MADRAS FISHERIES DEPARTMENT.

THE EDIBLE MOLLUSCS OF THE MADRAS PRESIDENCY

BY

JAMES HORNELL, F.L.S.,

Government Marine Biologist, Madras.

Report No. 1 (1917),

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THE EDIBLE MOLLUSCS OF THE MADRAS PRESIDENCY.

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JAMES HORNELL F.L.S.,
GOVERNMENT MARINE BIOLOGIST, MADRAS.

Except in Malabar the utilization of shellfish properly so-called has comparatively little economic importance at the present moment in the Madras Presidency. If Cephalopods, which are specialized and highly developed molluscs, be included, then Palk Bay may be added as a second locality, as several species of Octopus, Squid and Cuttlefish rise there to a position of considerable value in the economy of the lives of our fisherfolk. Except in these two localities the molluscan resources of our seas are largely neglected and undeveloped. Apart from the poorer classes of coast dwellers, shellfish as an article of food is generally despised, and except in the instance of oysters in Madras City, of mussels in Malabar, and squid in Ramnad district, none is ever seen exposed for sale in South Indian fish markets. When one remembers the important position occupied by various species of shellfish in the littoral fishing industries of other countries—Britain, France, the United States, and Japan are instances—this fact is much to be regretted, and it behoves the Fisheries Department to do everything possible to remove prejudice against the inclusion of shellfish in the general dietary of our towns and to increase the quantity and quality of those kinds which are both suitable from the food standpoint as well as susceptible by cultivation of extended increase in the amount available for distribution. It may also be found necessary to supplement our indigenous supplies by the introduction of larger and more prolific species and varieties from other countries; the discovery and introduction of such improved kinds should be kept steadily in view in all attempts to increase and improve our supplies of shellfish.

In this connexion it is notable that some shellfish highly valued in other parts of the world and occurring there in great abundance, are scarce and usually of small size in India. Four of the most

notable are the scallops or pectens, the ear-shell *(Haliotis)*, the true cockle *(Cardium)* and the limpet *(Patella)*. Examples of all these occur on our Indian coasts but all are extremely scarce and in the case of the very valuable Haliotis, the size seldom exceeds 1½ inch in length, as compared with the British, Japanese and Californian species which vary from 4 to 6 inches in length. Several species of Indian Cardium are larger than the British forms, but they are seldom found alive, though dead valves are not uncommon on Coromandel beaches.

The need to protect the sources of supply from sewage contamination must also receive careful attention; many shellfish from their habits are liable to ingest bacteria from the water flowing over the beds, and whenever this be heavily charged with sewage, certain kinds, oysters in particular, which are often eaten either raw or lightly cooked, may transmit the infection and cause enteric fever and possibly other forms of bacterial disease. This point will receive further attention when treating of the edible oyster.

The following list and notes are not to be regarded as complete and exhaustive; lack of adequate skilled assistance has limited my tours largely to the southern section of the Presidency and this has prevented me from obtaining intimate acquaintance with many important fishing localities on the Madras seaboard, particularly with those northward of Pulicat Lake. To facilitate the identification of the forms mentioned below, text-figures of the more important are given. These are all original and drawn from life. For the care taken in their delineation, much commendation is due to Mr. M. Ramaswami Nayudu, B.A., my Shellfish Sub-Assistant, who is responsible for the whole series.

Catalogue of Madras Edible Molluscs.

A.—Species in common use.

Pelecypoda or Lamellibranchiata.

Species.	English.	Tamil.
Mytilus smaragdinus	Green mussel ...	Kallikai; Pachchai āli.
Mytilus sp.	Brown mussel ...	Kallikai.
Arca granosa	Ark-shell	Vari matti.
Ostrea virginiana	Backwater edible oyster.	Āli; Pātti.
Ostrea cucullata	Rock oyster ...	

PELECYPODA OR LAMELLIBRANCHIATA—*cont.*

Species.	English.	Tamil.
Meretrix casta	Backwater clams...	Matti.
Meretrix casta ovum		
Meretrix meretrix		Panjamatti.
Velorita cochinensis		...
Donax cuneata	...	Mural, and Vāzhi matti.
Circe gibba	Cockle clam ...	Vari matti.
Donax scortum	...	...
Mactra corbiculoides	...	Sevala matti.
Mesodesma glabratum	...	Kakkamatti.
Tapes ceylonensis	...	Vazhukkumatti.
Lamellidens marginalis	Fresh-water mussel.	...

GASTROPODA.

Turbinella pyrum	Chank	Sangu.
Pterocera lambis...	Five-fingered chank.	Aiviral sangu.
Turbo margaritaceus	Turban shell ...	Nathai.
Oliva gibbosa	Olive	Kovanji and Sangu.
Purpura rudolphi	Rock whelk ...	Par attai.
Conus spp.	Cone	Semman utti.
Strombus canarium	...	Viranjan.
Patella spp.	Limpets	Unai.
Ampullaria sp.	Fresh-water snails.	Nathai.
Vivipara sp.		Umachchi.

CEPHALOPODA.

Loligo spp.	Squid	Eekki kanavai.
		Kundal ,,
Sepia spp.	Cuttlefish ...	Ottu ,,
Octopus sp.	Small devilfish ...	Pey ,,
		Sa ,,
		Sangu ,,
Do. sp.	Large ,, ...	Kundal ,,

B.—Species not utilized at present as food.

Margaritifera vulgaris	Pearl oyster ...	Mutthu chippi.
Modiola spp.	Weaving mussel ...	...
Pinna sp.	...	Akku.

B.—Species not utilized at present as food—cont.

Species.	English.	Tamil.
Barbatia barbata	Hairy ark-shell ...	...
Parallelopipedum tortum ...	Twisted ark-shell.	...
Solen sp.	Razor-shell ...	Pul akku.
Potamides (Telescopium) fuscum.	Horn-shell ...	...
Potamides (Pyrazus) palustris ...	Do. ...	...
Melongena vespertilio	Knobbed whelk ...	...
Helix spp. ... ... } Ariophanta spp. ... ... }	Land snails ...	...

MUSSELS (MYTILIDÆ).

Tamil—*Kallikai* (கள்ளிக்காய்) in the south; *Pachchai āli* (பச்சை ஆளி) at Pulicat.

Malayalam—*Kaduka* and *Kadalkai* in South Malabar; *Kallumakkai* in North Malabar; *Nilakākka* in Cochin.

Kanarese—*Pacile.*

Tulu (North Kanara)—*Ajeer.*

Two species only of true Mussels (Mytilidæ) grow to a considerable size in the waters of this Presidency. One of these is the very handsome Green Mussel (*Mytilus smaragdinus* Chem.), readily recognized because of the handsome green coloration of the horny membrane or periostracum investing the exterior surface of its valves; the other is an even larger species, less elegant in contour, coated with a coarse brown periostracum that looks commonplace when contrasted with the vivid tint of the green. The former species is distributed widely upon the Madras coasts, extending as it does almost continuously from South Kanara on the west coast to the borders of Orissa on the east. The brown form, on the other hand, is confined, so far as I am aware, to the extreme south of Travancore and of the Tinnevelly district.

No representatives of the closely related genus *Modiola* are eaten, although several species are found, particularly in Palk Bay, where the sea-bottom is frequently carpeted over hundreds of acres with vast multitudes of *Modiola barbata*, *M. japonica*, and allied forms. These seldom grow more than an inch in length and live generally at a depth of three to five fathoms, hence their non-utilization as food. Could they be cheaply collected in quantity, they would form both an excellent food and, when dried and pulverized, a first-class manure.

Throughout South Malabar the green mussel is usually termed *Kaduka* which appears to be a corruption of *Kadalkai* ("sea-fruit") by which name it is known amongst better educated people; in Cochin this same shellfish is known as *Nilakākka*, the "long kākka," in contradistinction to the ordinary Kakka which is the common backwater clam (*Meretrix casta ovum*).

Mytilus smaragdinus, although so widely distributed, is found in large quantity only on the west coast from South Kanara to the northern part of Travancore. Within these boundaries, wherever rocks are found inside of the three-fathom line, the green mussel

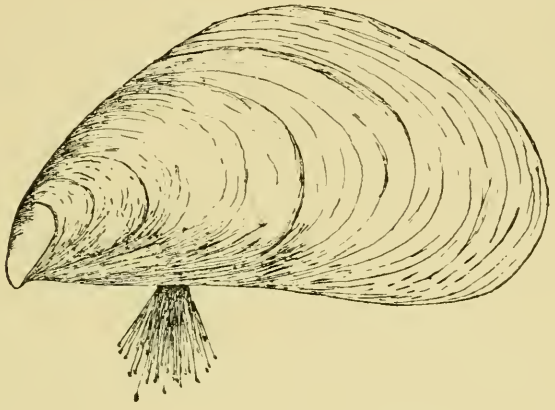

FIG. 1.—THE GREEN MUSSEL. ×$\frac{3}{4}$.

usually finds conditions favourable and covers all exposed rocky surfaces and the walls of all crannies with its closely set multitudes. Wherever it is found, it is accompanied by edible oysters—chiefly *Ostrea virginiana*; we can clearly distinguish an *O. virginiana—M. smaragdinus* formation in such situations on both the east and west coasts. The rocky coast of South Kanara from Gangoli to Kāp, and that stretch of the Malabar coast from Eli Mala to Kadalundi are the two localities where conditions are most favourable for its growth; these localities produce the great bulk of the mussels consumed in these two districts. The south section of Malabar is too sandy and rockless to give foothold and few mussels are fished there.

The collection of mussels is a minor marine industry of some importance at several places, especially in the neighbourhood of Cannanore, Tellicherry, Mahē and Calicut, and also in Travancore.

The flesh is highly esteemed and is eaten by Muhammadans and Christians and by all Hindu castes inferior to the Nayars; in Malabar I understand however that even the last named consider mussels as a delicacy, although those of Travancore will not partake of them. Kitchen-middens composed largely of these shells, are often to be seen near huts as the train passes along the coast line between Calicut and Cannanore.

As the higher range of these mussels extends just above the low water level of spring tides, the greater quantity is got by collection from rocks exposed or awash at spring tides; a considerable number is however obtained from deeper water by divers. Both at Cannanore and at Tellicherry there are a few Mappillas who prosecute this industry for a few months in the year. The diver carries with him a coir bag and a bamboo stick sharpened at each end. With the latter he separates the mussels from the rocks and then brings them to the surface in the bag. They are fished only during the dry months from December to May by which time they have attained edible dimensions. During the south-west monsoon it is impossible to gather any owing to the violence of the sea and for a few months thereafter they are too small in size to be worth taking.

Cannanore, Tellicherry and Mahē are the only towns in Malabar where mussels are exposed for sale in the public markets. About half a dozen basketsful may be sold per day during the season. The demand is particularly active when fish is scarce and dear. In Calicut, Beypore, Badagara and some other large towns they are occasionally hawked through the streets. In other places there is no regular trade; the fisherfolk and other coast people living in the neighbourhood of mussel rocks, gather supplies at low tide for their own use and sometimes sell any surplus they have. A basketful weighing from 40 to 50 lb. fetches from 8 to 12 annas. The retail price when fish is scarce and mussels are in good demand in consequence, runs to about 30 to 40 for one anna.

Methods of Cooking.—In Malabar cuisine mussels are usually either made into curries or else are fried. In both cases the shells are first boiled just long enough to cause the valves to open, when the flesh is extracted and washed, and either cooked with curry stuff or fried in coconut oil after rolling in a curry batter, called *massala* paste.

Among the Mappillas a much more refined method prevails. After removing the flesh from the shells, each body is stuffed with

rice dough and steamed in a most ingenious and effective manner; a cooking vessel is half filled with water, a cloth is tied over the mouth, the stuffed mussels are laid on the cloth, and then another earthen vessel is inverted over the mouth of the first and the whole placed over a fire till it be judged the steaming is complete. Of the three methods described this last appears to be the most satisfactory; the frying method is probably the worst for people with poor digestion though it is doubtless the most tasty. Mussels are often furnished in coast toddy shops to customers who find them a good relish.

There is some question as to whether the demand for mussels on the Malabar coast is sufficiently great as to outstrip supply; a satisfactory method of cultivation whereby the supply could be largely increased and cheapened might be of much value to the coastal population. The exposed nature of the coast during the south-west monsoon would however render such an undertaking exceedingly difficult except at a prohibitive cost. Demand would probably be greater if the methods employed to cook them were more appropriate. Some of those employed, notably frying in oil, are likely to make them indigestible.

When the subject of framing regulations for the protection of immature fish throughout this Presidency becomes ripe for treatment, the question of the desirability of imposing a minimum size limit for mussels should also be included, as there is evidence that in some localities collection is occasionally so intensive as to reduce the average marketed size to objectionably small dimensions.

On the East Coast, the green mussel is comparatively rare; nowhere is it found in thickly stocked beds as in Malabar and Kanara. Yet almost everywhere along the coast occasional stragglers are found and in several estuarine backwaters where beds of the edible oyster (*O. virginiana*) occur, they become comparatively numerous. In the Government Oyster Farm in Pulicat Lake, about a couple of score can usually be collected in a day by one man from among the oyster clumps. At Pulicat where they are known as *Pachchai āli* or green oysters, they are occasionally utilized by Pariahs who eat the flesh cooked with curry-stuffs.

In the Sonapur backwater in Ganjām district this mussel is fairly abundant, considerably more so than at Pulicat. As in the latter locality, its habitat is on the oyster patches in the deeper parts of the backwater. Particularly numerous is it in the deep main

channel near the Fish-curing Yard at Revu Sonapur village. Here occurs a deposit of large oysters living in great clustered clumps; in the angles and crevices of these masses the green mussels find suitable lodgment. They vary from single individuals to groups of three or four; seldom do they exceed this number; they never form a massive deposit nor do they ever cover their habitat with a living carpet as they do in Malabar. At Sonapur they have economic value but not as food. Owing to certain characteristics of this back-water these mussels are largely infected with the larvæ of parasitic worms, and, induced by the irritation thus produced, pearl formation is frequent. For many years past this peculiarity of the Sonapur mussels has persisted and those of the local fishermen who can dive, devote considerable attention to the mussel fishery at times when the water in the channel is low. The pearls found are moderate in size and of poor colour, usually pinkish, but as the mussels yield them fairly abundantly, the beds are well exploited. I saw a few of these mussel pearls when at Sonapur in May 1915, and I was informed that the price paid by the local dealers to the fishermen ranges between Rs. 5 and Rs. 10 per tola.

From the observations made (which I hope to amplify shortly) these pearls are found to have a related origin to that of the pearls sometimes produced in quantity by the common mussel (*Mytilus edulis* L.) of France and England. The Sonapur backwater is the haunt of myriads of seagulls and waterfowl and it is from the adult parasites contained in the alimentary canals of these birds that the flat-worm larvæ found in the adult mussels are derived. Under certain circumstances occasional larvæ induce the formation of pearls in the mantle of the mussel, the dead body of the parasite persisting as the nucleus of the pearl. The life-history of the Sonapur pearl-inducing parasite has yet to be worked out.

The Brown Mussel (Mytilus sp.).

Tamil—*Kallikai* in South Travancore.

This mussel is the largest and stoutest species found in South India, attaining commonly a length of 4 inches. It is distinctly larger than the green mussel, but unlike the latter its distribution is limited to a comparatively short length of coast in South Travancore, where it displaces the green species. The coast there is exposed to exceptionally heavy seas during the monsoon, but in spite of this it thrives in great abundance on rocks from low tide level to a depth of about 2½ or 3 fathoms. Annually large quantities

are taken from the rocks by divers. They form an important food item among fishermen and coast Muhammadans.

The Ribbed Ark-shell (Arca granosa, Linn.).

Tamil—*Vari matti* (வரிமட்டி).

This fine shell is nowhere common. In appearance it looks like a very rugose cockle; the flesh is distinctively coloured red, due to the blood being of this hue, an exceptional condition among molluscs where the blood is generally colourless or tinted pale bluish green.

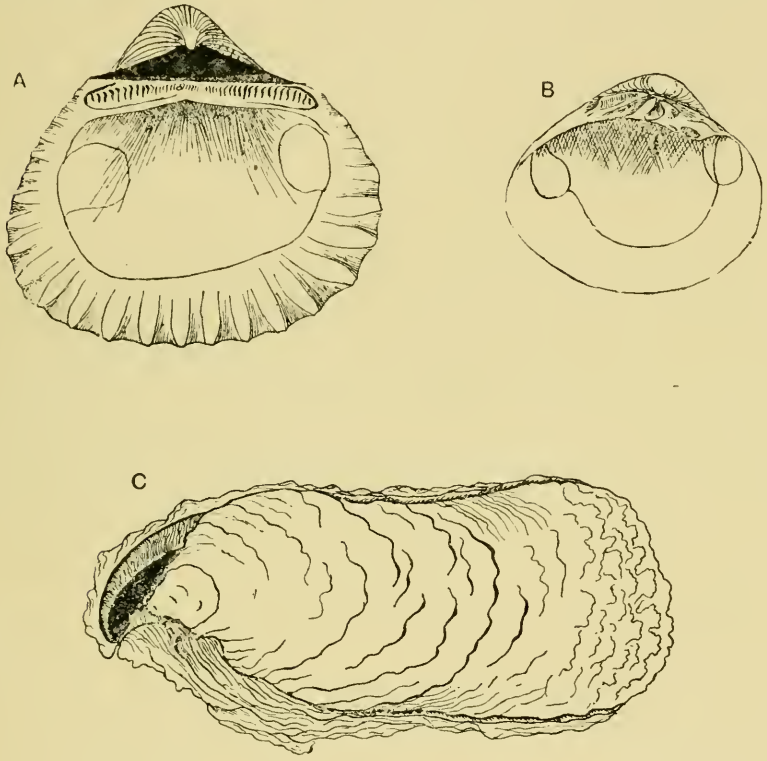

Fig. 2.—A. Ribbed Ark-shell. × 1.
B. Common matti or clam. × ¾.
C. Backwater oyster (*O virginiana*) × ½.

It occurs sparingly distributed in sandy backwaters on the East Coast. In Pulicat Lake it is not uncommon.

The flesh is tough, but because, presumably, of its red colour, some shore dwellers have the idea that it has specially nutritious and strengthening qualities; on this account it is often given to women during pregnancy.

In size it seldom exceeds 53 mm. in length by a thickness of 42 mm.

It is noteworthy that this species is reported to be the subject of very profitable cultivation in Japan, where from one culture area of 830 acres between 75,000 and 100,000 bushels are obtained annually. The methods employed are simple; they depend for success upon the fact that the fry of Arca, after quitting the free-swimming stage, tend to settle in definite areas in great quantities. Once these are discovered the young ark-shells can be raked up in thousands—usually when they are about 3 mm. long—and transplanted to culture grounds where they are strewn and left to burrow into the bottom. As they grow larger, from time to time they are redistributed in order that overcrowding and food shortage may be avoided. They are said to attain a marketable size in their third year. The bulk of the produce is exported to China.

OYSTERS (OSTREIDÆ).

Tamil—*Ali* (ஆலி), Pulicat; *Pātti* (பாட்டி), Tuticorin.

Malayalam—*Muringa* in Travancore and Cochin; *Muru* in Calicut.

The edible oysters of Madras Presidency are two in number, the backwater or mud oyster (*Ostrea virginiana* Gmelin) and the rock-oyster (*O. cucullata* Born). The former is the one specially valued and the one which lends itself to cultivation; the second, whilst good flavoured, is rather tougher as well as smaller than the other and is seldom eaten except at one or two places on the Kanarese coast where it is specially abundant.

The Madras backwater oyster is extremely variable in form and has passed under many names. Among the more recent under which it has been described is that of *O. madrasensis* by Preston[1]. It has however no outstanding differences from the common American species and I agree with Vredenburg in believing it to be in nowise separable from this widely distributed form. It is appropriate to say here that very little is known at present concerning the number and relationship of the different Ostreids of Indian waters, and their nomenclature is in a state of considerable confusion. A review of the species is urgently needed. To this end I am accumulating material and I shall be very grateful for

[1] Preston, H. B.—Report on a collection of Mollusca from the Cochin and Ennur backwaters. *Records of the Indian Museum*, Vol. XII, part 1, Calcutta, 1916.

any representative specimens from different parts of India, Ceylon, Burma, and the Persian Gulf, that any one in a position to help, may be kind enough to send. No less than half a dozen shells should be sent from each locality and these should comprise as great a variety of form as possible. The typical or most common form assumed in each locality, should be distinctively indicated, wherever possible.

This species of oyster under notice is very hardy and can sustain considerable fluctuations in the salinity of the water it lives in. Hence it thrives in nearly every estuary and backwater on both the coasts of the Presidency ; only exceptionally, as on some rocks situated near estuaries on the Malabar coast, does it form considerable deposits in the open sea, although odd individuals are often met with wherever rocks occur upon the littoral. Young oysters of this species are also often met with on shells in water up to 8 fathoms in depth, but these do not thrive and seldom survive to maturity.

Backwater oysters have considerable value to the poorer population living in the neighbourhood; the chief centres on the west coast are the backwaters at Tellicherry and Beypore in Malabar, Cochin and Azhikode in Cochin State and Vembanad backwater in Travancore. On the east coast the backwaters at Cuddalore, Covelong, Ennur and Pulicat are famed for the abundance of their oyster beds, while further north there are extensive beds in the deltas of the Kistna and Gōdāvari and in the backwaters of Vizagapatam and Ganjām. The oyster beds of Sonapur backwater in Ganjām are the most extensive of these latter.

Unfortunately the better classes of Indians do not appreciate oysters and none will make use of this excellent food-supply. Among Hindus, only the lower classes of shore dwellers eat oysters, together with some Muhammadans and Indian Christians. The only better class trade in oysters is that supplying the requirements of Europeans and Anglo-Indians in a few of the larger coast towns, as Madras, Calicut, Cochin and Mangalore. Many of the sources of supply are however under grave suspicion of possible sewage contamination. Because of this and in order to provide a supply of good quality oysters free from any danger of being disease carriers, Government in 1910 permitted the Fisheries Department to form a model oyster park in Pulicat Lake where oysters are cultivated under hygienic conditions and thence distributed throughout the length and breadth of the Presidency.

The most extensive oyster beds in South India are those in Cochin harbour and in Vembanad backwater in Travancore. In both localities oysters are exceedingly numerous, the flesh finding a ready sale among the lower classes. In the Vembanad villages, the flesh, called *Moringa irachi*, is said to be regularly exposed for sale in the fish market. In Cochin it is not seen in the markets, being hawked about the streets in small-mouthed chatties. The beds in Cochin harbour chiefly lie within what are claimed to be Cochin State limits and the right to fish oysters is let annually by the Darbar for a small sum, seldom if ever exceeding Rs. 100 per annum. In practice, the lessee sublets the right to individual divers who pay him a small sum for each day's fishing. The divers are usually Roman Catholic Christians. As the water over the beds varies from one to three fathoms the men require to dive for the oysters; when the current is strong the assistance of a pole thrust into the bottom is resorted to, the diver using this to prevent himself being carried away. As the oyster clumps are collected they are piled into a small attendant dug-out canoe and as soon as this is full, a matter of some three hours' work, the spoil is taken to the shore where women purchase it at the rate of from 10 annas to 1 rupee per lot—a quantity usually averaging about 800, or a rate of 1½ to 2 annas per hundred. The buyers proceed to open them, putting the flesh into an earthen pot containing a little water. This flesh they hawk through the town at from 2 to 4 annas the hundred. Surplus oysters are sometimes kept alive in the canals till wanted—an extremely insanitary proceeding.

Oyster flesh is never eaten uncooked by Indians; the common method of preparation on this coast is to fry the flesh in ghee after flavouring with salt and condiments. The trade is of considerable volume in Cochin in spite of the fact that many of the largest beds are subject to sewage contamination. The fact that the flesh is never eaten except after cooking appears to be an effective safeguard. It is noteworthy that the discarded oyster shells, in the absence of any local rock, are put to extensive use in reclaiming swamp land and as foundations for buildings.

In the Beypore, Elattur and Tellicherry backwaters, oysters abound wherever rocks occur and good quantities are taken annually by the womenfolk of the local Hindu fishing communities, who collect oyster flesh at low tide, breaking open the shells with short iron knives as they occur *in situ* and transferring the flesh to small chatties which they take with them.

On the east coast, in the backwaters in the neighbourhood of Madras, a certain amount of oyster flesh is collected and eaten by the local Pariah population. Sometimes Muhammadans will have some, but this appears to be done in imitation of the European custom. In these places the bulk of the oysters consumed, as already mentioned, is by the Europeans and Anglo-Indians of the large towns.

Further north, in Ganjām district, certain sections of the fishing population make a limited use of the local oysters, particularly those in the Sonapur backwater where the Bairavi women are accustomed to visit the beds at low water, break open the shells and carry away the flesh in chatties to use in their own curries.

Seasons and spawning.—The season when oysters are in marketable condition depends upon the time of spawning and this in turn is controlled by rainfall and sunshine. Heavy rains causing flood water to enter backwaters in such amount as to greatly lower the salinity of the water over the beds, invariably entail widespread and immediate emission of the reproductive products in all oysters where the gonads are well filled. Hence as the rainy season differs on the two main coasts of India, there is a corresponding divergence in the spawning maxima and in the marketable season in these two localities.

On the Malabar coast the chief spawning maximum occurs about midsummer or even earlier, at the onset of the south-west monsoon and the oysters are not again in condition till October or November. From this time onwards they improve in quality till about the end of March; thenceforward till the final and complete spatting at the end of May or early in June, there is a good deal of irregular spatting induced by the hot weather then prevailing, emphasized by the exposure and semi-drying of many of the oyster-covered rocks during low water of the major spring tides. Between March and June a considerable percentage of spent oysters are always found in any number examined; the gonads of those that spawned early in March will be partly full again when the floods arrive in June and these, after enduring the lowered salinity of the water for a while, will at last emit their spawn though perhaps only half mature. Long continued floods cause very extensive mortality on the beds, and few survive except the small number living on the bottom of deep channels. In these places saline conditions appear to last much longer than on the surface,

the lighter gravity of flood water causing it to pass over the deeps without clearing out completely the saline water which was there before the onset of the floods. Spawning in the case of these few surviving oysters appears to be deferred till about the end of August when the floods have partly subsided and tidal conditions are re-established. Much variation exists however in this cycle of events, for under normal conditions the common Indian oyster is a most irregular spawner; except when the floods are on, some individuals with ripe gonads can always be found; hence there is no definite and universal spawning season as the case of the English oyster (*O. edulis*). Mortality amongst oysters during the rains is confined to those living well within the backwaters; those close to the mouth suffer less and many survive, except in exceptional years when the floods are very long continued. Much, too, depends on the physical conformation of the backwater. In such a one as that at Cochin, the oysters on the beds in the harbour usually survive, the considerable (relative) depth of water over the beds constituting a protection.

On the Coromandel coast, as the floods take place generally from the end of August until November, the season runs from December to the middle of August, with a partial break about April when a large proportion of oysters spawn. August and September constitute the main spawning maximum, induced in part by the hot weather prevailing then and in part by the lowering of salinity due to flood water. In a wet season the latter is the main factor; in exceptionally dry ones or when the rains are long deferred, the former is the effective factor. A second maximal spawning takes place in March and April, and between this time and August, spawning individuals can always be found.

The reproductive habits of this oyster are similar to those of the Indian Pearl-oyster (*Margaritifera vulgaris*) and closely akin to those of the Portuguese oyster (*Ostrea angulata*). In all these species the sexes are separate; the ripe ova and spermatozoa are poured forth freely into the surrounding water when a sufficient stimulus is experienced. Fertilization takes place in the water outside the parents' bodies, trochophore and veliger forms being in turn assumed during the growth of the fertilized ova. The free-swimming stages last for several days and in this time they may be carried by currents for considerable distances, thus ensuring wide dispersion throughout the neighbouring coasts. The free-swimming spat when ready to attach is easily obtained in any suitable estuary or back-

water by the employment of spat collectors ; experience shows that ordinary country roofing tiles, arranged in low piles of several rows, are the most suitable form to use. During our first experiments at Pulicat, we arranged these collectors with a view to catch the spat produced during the September spawning season ; experience shows that it is preferable to aim at obtaining the necessary spat during spring (first half of April), as the parent oysters are in much better health then ; the results obtained are altogether better, for operations can then be carried out with greater facility, the water level in the parks being lower than it is in September.

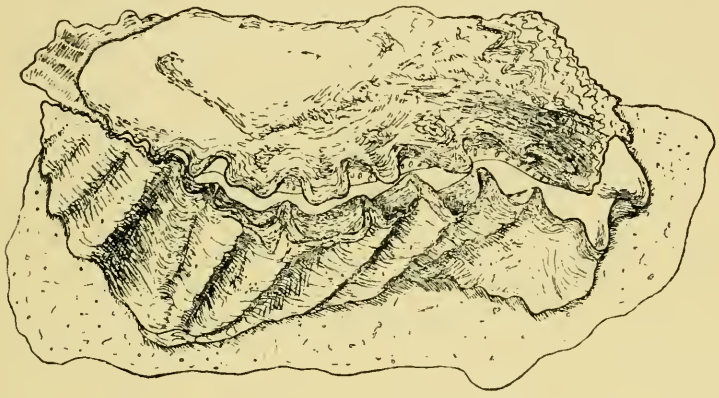

FIG. 3.—THE ROCK OYSTER (*Ostrea cucullata*). Natural size.

THE ROCK OYSTER—OSTREA CUCULLATA (Born).

This oyster differs greatly from the backwater oyster. Its main distinguishing characters are as follows :—

Outline roughly oval ; the left valve extensively attached, deep and cup-shaped, with a sacciform extension into the hollow beak region of the hinge, which is moderately elongate in freely-grown individuals ; the edges of this valve have a distinct tendency to grow upwards. Externally the left valve is folded into deep ridges passing radially outwards from the hinge and ending in a strongly dentate edge which tightly interlocks with the edge of the upper or right valve. The latter is flattened and opercular in form. The muscle scar of both valves is usually dark purplish-black in tint, rarely white. Very characteristic is a row of closely set elongated denticulations seen a short distance inwards from the margin on the inner surface of the upper valve ; these fit into a

corresponding series of furrows in the lower valve. Externally the shell is tinted an opaque pinkish purple. Internally it is white, margined with purple or black. The size is generally smaller than that of the ordinary backwater or mud-oyster and seldom exceeds three inches in length.

The habitat of rock oysters is a narrow band between tide marks; during ordinary spring tides, these oysters are entirely uncovered at low tide. They are purely a marine species, never forming beds in backwaters or estuaries, though an occasional dwarfed individual is occasionally to be seen among backwater oysters.

Under favourable conditions they form densely crowded colonies upon rocks between tide marks; the finest example of such beds which I know, is on the rocky shores of St. Mary's Isles, off Malpe, in South Kanara. They are of excellent flavour, but on account of their small size, both natural and often further reduced by overcrowding, as well as the difficulty experienced in opening them by reason of their interlocking edges, they are not of any economic importance.

BACKWATER CLAMS.

At least four estuarine clams of value as food are found in the Presidency, namely :—

Meretrix meretrix, *M. casta*, *M. casta* var. *ovum*, and *Velorita cochinensis*. (See Fig. 4).

The first of these is comparatively scarce, and the third, which is of chief importance in Malabar, is not found on the east coast where *M. casta* takes its place as the most abundant of backwater clams.

THE SMALL CLAMS (MERETRIX CASTA AND M. CASTA var. OVUM).

Tamil—*Matti* (மட்டி).

Malayalam—*Erunthu* at Calicut ; *Kākka* at Cochin.

Everywhere along the coast from South Kanara in the west round to Ganjām in the east, with the exception of the Gulf of Mannar and Palk Bay, either one or other of these little clams is found abundantly in muddy sand in estuaries and connected backwaters wherever the water remains saline throughout the greater part of the year. Suitable conditions prevail over more extensive areas on the west coast, and it is there, *par excellence*, that these clams attain their greatest importance.

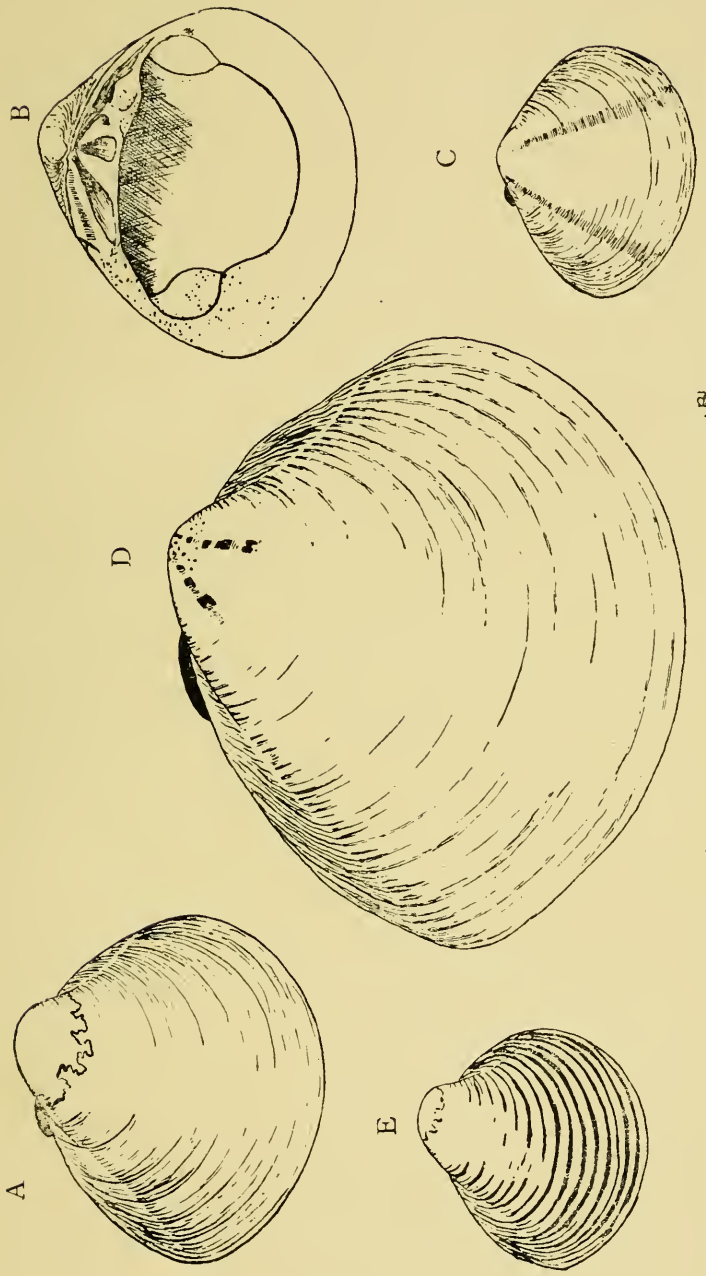

FIG. 4.—BACKWATER CLAMS.

A & B.—*Meretrix casta*, outer and inner view of a valve; C.—*Meretrix casta* var. *ovum*; D.—*Meretrix meretrix*; E.—*Velorita cochinensis*.
All natural size except E, which is × $\frac{2}{3}$.

Meretrix casta var. *ovum* (Hanley). The valves of this subspecies or variety are described as usually ovate to oblong, subequilateral, covered with a thin greyish-yellow periostracum and either with or without two narrow brown bands radiating from the hinge region ; the umbones centrally disposed and often corroded ; the posterior margin stained greenish grey ; length seldom exceeding 40 mm.

Such a description serves well for the species found in great abundance in west coast backwaters, although when overfished as in the Beypore River, the average size becomes considerably reduced, as few individuals have an opportunity to reach maturity. The two dark rays thought faint and easily overlooked, are very characteristic of this variety ; only occasionally in the adult can these rays be traced back to the umbo ; they are usually best marked towards the ventral margin where they often terminate in two small reddish brown colour patches on the extreme edge. The periostracum is well developed and persistent ; it varies from a distinct pale cream to a rufous yellow or even brown, the darker tints being largely of stain origin. The posterior margin usually appears of a greenish tinge in shells from Beypore River until the periostracum be removed, when it is revealed as actually greyish blue in tint.

This clam is probably the most important food mollusc of the Presidency. Its flesh is of good flavour, tender and nutritious. To the poorer classes of shore dwellers, wherever it is obtainable in quantity, it often takes the place of fish in their curries when this is dear or scarce and is esteemed both for its cheapness and tastiness. On the Malabar coast these clams are largely collected by low caste people who hawk canoe-loads along the backwaters and canals. The usual retail rate varies from one to two pies per seer, indeed a pie's worth is considered in Malabar sufficient to make a curry for a whole household. The Malabar clam fishers usually use very small dugout canoes, which are anchored when the fishing ground is reached. Men, women, and lads all engage in the fishing ; the feet are used to locate and dislodge the clams when these occur in shallow water. In deep channels diving has to be resorted to.

Amongst the common sights in Malabar are heaps of discarded *crunthu* shells forming miniature kitchen middens in the neighbourhood of many huts ; these are sold eventually to lime-burners, as the shell of this clam, being exceptionally massive, is valued

highly as a source of high-class lime, particularly suitable for white-washing purposes.

On the east coast, the place of *M. casta ovum* is taken by the type form of *Meretrix casta* (Gmelin), a rather larger and stouter shell of the same habits, known generally as *matti* in Tamil districts. Its valves are thick and massive, the exterior covered with a strongly adherent brownish yellow periostracum, dull in appearance, that varies much in tint even in one locality. A dark purplish black band margins the posterior edges of the shell to a depth of about a quarter of an inch, extending from the hinge to the posterior angle of the shell; unlike the yellowish colouring of the rest of the shell, this purple pigment permeates the substance of the valves and shows equally upon both the inner and the outer surface. The shell exhibits none of the radial banding of the sub-species, nor any of the diverse colour schemes of spots and chevrons so often found on the umbones of *M. meretrix*.

Although often very abundant it is generally less common than the corresponding species on the west coast and is held in less esteem by the people. It is however eagerly sought for wherever it abounds. At Pulicat, for instance, as many as 30 women may often be seen collecting this shellfish in the shallows opposite the town. Unlike the custom in Malabar, men here seldom engage in this work; Pariah women and girls alone carry it on. They work for preference during low tide when the depth of water is reduced over the beds. From time to time as they gather the clams, they pile them in heaps on an adjacent sandbank. When they judge it time to drop fishing, they adjourn to the sandbank, and there proceed to smash the clams one by one by striking them against a heavy stone. As each is broken open they deftly extract the meat with a push of the thumb, dropping it into a small earthen pot containing a little water. In this way in a short time each woman has emptied the whole of her catch, amounting to several hundreds. The broken shells are left behind for the lessee who has bought the right to the shells for lime-making, and who permits these women to collect them on this condition.

Women's wages at Pulicat average 2½ to 3 annas per day and the value of the catch of clams made in a day by one woman working hard, is usually valued at this amount. The bulk of the clam meat obtained is however generally used to supply the needs of the woman's own family; if any surplus is left, it is often

exchanged for paddy, bulk for bulk, I am informed. At times when specially large quantities are obtainable, the surplus flesh is sundried to serve as stock for use during the rainy season when the collection of clams is interrupted owing to increase in the depth of water over the beds.

Pariahs and Pallans and some of the Muhammadans and Christians of coast hamlets are the only people who eat these clams in Tamil districts.

On the east coast, spawning appears to take place twice in each year, the first during April and May, the second about September. The busiest fishing season at Pulicat and the neighbourhood is the hot dry season from June to August when the level of the backwaters and canals becomes much reduced, facilitating greatly the work of collection. At this season the condition of these clams is at its best, the bodies fat and swollen with reproductive products.

The Great Clam—Meretrix meretrix (Linn.).

Tamil—*Panjamatti* (பஞ்சமட்டி), Tuticorin.

This is a nearly related species to the common matti *(M. casta)*. It is distinguished by its greater size and by the smoothness and delicacy of the periostracum covering the valves. Its average size when adult ranges between 74 × 60 mm. and 75·× 62·5 mm. with a weight (empty) of about 3½ ounces. So long as the periostracum is intact the valves have a beautifully polished appearance due to the smoothness of this membrane, which is thin, delicate, and either grey or a pale straw colour in tint. Along the postero-dorsal margin of the shell there is a dark band of greyish blue in some and bluish brown in others; this colouring occupies precisely the same region as in the common clam *(M. casta)*. This is a very beautiful shell and the pity is that it is not more abundant. I have found it in the Silavathurai fish-farm at Tuticorin, in the seaward part of Pulicat Lake, and in a sub-fossil condition at Surla in Ganjām district. At Tuticorin it is fairly abundant, as a woman can easily collect from 30 to 40 in a tide. These clams are esteemed as food by the Valayans and Pallans who collect them and who use the empty shells for lime-burning. The flesh is considered less delicate than that of the common clam; the species seems less hardy; as a consequence its distribution is more local and

restricted—it requires a cleaner habitat than *M. casta* and a strong tidal current over the bed where it lives. Hence it is usually found near the entrance to lagoons, where the tidal flow is great. Spawning occurs about the beginning of September at Tuticorin, probably also about May.

The shell exhibits considerable variation in colouring; usually, apart from the postero-dorsal and umbonar regions, it exhibits no banding, but in a few (Tuticorin) there are very broad ill-defined radiating bands of a somewhat livid brown colour extending from the ventral margin to half way to the umbo. The umbo nearly always shows considerable colouring but this is extremely variable and no two shells are exactly alike in this respect. Most frequently a minute brownish speckling can be made out, either alone or associated with a more conspicuous and extensive zoning in a livid tint; in others this speckling resolves itself into a more distinct colouring of chevron-shaped chestnut markings, which may coalesce either into short rays or into concentric zones, never spreading far beyond the umbo.

The Black Clam—Velorita cochinensis (Hanley).

Malayalam—*Kar crunthu.*

This small thick-shelled clam is found only in west coast estuarine backwaters, where it is associated with the common clam *(Meretrix casta ovum).* Its shell is ribbed concentrically and covered by a coarse thick black periostracum which is frequently worn away by corrosion at the umbo, showing the whitish shell beneath. The interior is characteristically pale pink in tint. This clam can survive the prevalence of fresh-water conditions longer than the common clam; it was originally, I believe, a fresh-water species, and its presence in quantity in estuarine backwaters, subject during a considerable portion of the year to brackish water conditions, indicates a marked change in its habits and an acquired tolerance for saline conditions. It is used by the same people as eat the common clam and its valves are also employed in lime-burning in Malabar. It is not nearly so abundant as *Meretrix casta ovum;* its habitat is usually further distant from the sea than that of the latter species.

The shell seldom exceeds 40 mm. in length.

Mural (Donax cuneata Linn.).

Tamil—*Mural* (முரல்), Pulicat Lake; *Vāzhi matti* (வாழிமட்டி), Pāmbān.

This small, much compressed bivalve is roughly wedge-shaped in outline, the posterior part of the shell being obliquely truncate. It is abundant between tide-marks and for some short distance below low-water level. It never enters backwaters and is essentially a marine form. In size it seldom exceeds 40 mm. in length.

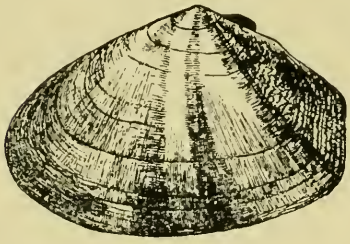

Fig. 5.—The Mural (*Donax cuneata* Linn). × 1½.

On the east coast, the mural usually abounds in great numbers, particularly on surf beaten sand flats. On the Malabar coast it is also plentiful but is usually smaller. In Tamil districts, especially on the Coromandel coast, the mural is chiefly valued by the fisherfolk (Pattanavars, etc.) whose lads are accustomed to collect it when rough weather cuts off the usual supplies of sea fish. The mural serves largely to meet such an emergency. It is seldom collected for sale.

The mural lives in the surface layer of sand; the boys who collect it turn over the wet sand with their feet as the tide recedes.

As usual with Indian fishermen the flesh of the mural is used in curries; sometimes it is put in whole, but in the neighbourhood of Madras it is more frequently ground into a paste after being boiled and incorporated with other ingredients of the curry.

Like so many other Indian molluscs, two maximal spawning periods can be made out, April—May and September, respectively.

The Cockle Clam (Circe gibba Lamk.).

Tamil—*Vari matti* (வரிமட்டி).

This shell is particularly plentiful in Palk Bay and the Gulf of Mannar where, especially in the former area, its collection is important to the Kadayans, Valayans and allied coast castes.

It is a strongly ribbed white shell with a superficial resemblance to the European cockle (*Cardium edule*)—the ridges running radially from the umbo to the margin—and of about the same average size. Its dimensions average when fully grown 45 × 37 mm. with a thickness of about 33 mm. It spawns about the beginning of September at Tuticorin. It frequents muddy sands

near low-tide level both along the open coast and in backwaters and estuaries. The flavour is good and the flesh tender.

Collection takes place at low water during spring tides, when the poorer women of the coast villages devote themselves to this work for two or three hours daily. In this time each can gather between 300 and 400 shells.

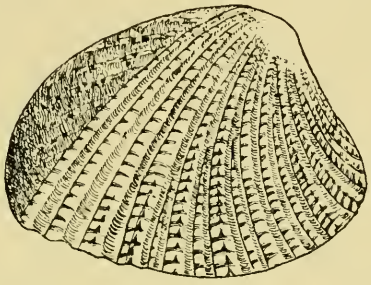

FIG. 6.—CIRCE GIBBA Lamk. Natural size.

The muddy flats between Pāmban and Kundagal Point are rich collecting grounds and many women may be often seen there engaged in the search at spring tide. Very frequently a couple of shells are kept in one hand and rubbed or struck against one another to produce a clicking sound. When questioned the women say that this has the effect of attracting the clams to the surface; they watch for a slight movement wherever they see clam burrows and scoop up the sand where this occurs, generally getting one or two shells. I am inclined to think that in reality the clicking sound has an opposite effect to that believed by the clammers; it really alarms the clam and causes it suddenly to retract its siphons and close its valves. In so doing a slight movement of the mud at the entrance to its burrow is necessarily caused and it is this that reveals its presence. Alphæids—the so-called "clicking prawns"—are common on these flats and possibly the noise made by striking two shells together is mistaken by the clams for the clicking of Alphæids.

The flesh is used either to form a curry, a soup, or a savoury, this considerable variety betokening the high esteem in which it is held. In all cases the preparatory operation is to steam the shells open and extract the flesh. This may then be made forthwith into a curry with the usual condiments, or it may be ground fine with coconut and spices, and boiled to form a highly tasty and nutritious soup, or, lastly, it may be ground to a paste, and fried in ghee or in sesamum oil and eaten with other food. The last mode

of preparation is a strong favourite with those who habitually utilize this food.

Probably no other bivalve is so universally valued on the shores of Palk Bay as is this cockle-clam—everybody seems fond of it with the exception of the higher caste Hindus.

The empty shells are used for lime-burning on the shores of Palk Bay, where it is the most abundant littoral mollusc. Along the Coromandel coast, *Circe gibba* is scarce and does not seem to be used there as food. It is not found on the Malabar coast.

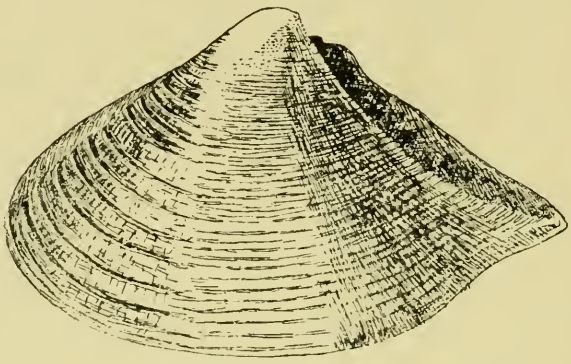

FIG. 7.—DONAX SCORTUM. × 1½.

MISCELLANEOUS MARINE CLAMS.

Malayalam—*Oraikai*, Calicut.

Besides *Circe gibba* and *Donax cuneata*, a number of other marine bivalves, chiefly Mactrids and species of related families are taken for food when met with in the search for the first named. Among the principal of these are *Donax scortum*, a fine purple tinted species

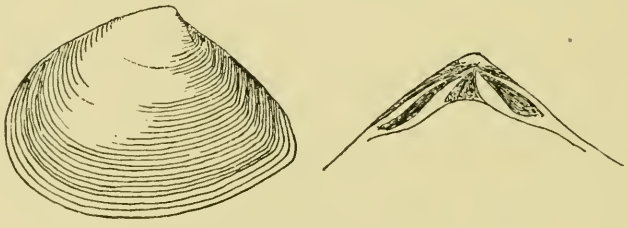

FIG. 8.—KAKKAMATTI (*Mesodesma glabratum*).
The figure on the right shows the structure of the hinge

growing to a length of 60 mm., strongly sculptured with coarse concentric ridges, and several species of *Mactra* and *Mesodesma*. One of the latter, called Kakkamatti (*Mesodesma glabratum*, Lamk.),

is pretty frequent along the island beaches near Pāmban and is fished and treated for food in the same way as *Circe gibba;* it grows to a length of 34 mm.; the shell, sculptured with bold concentric ridges, is white in colour, covered partially with a dirty yellow skin of periostracum (Fig. 8). The pretty little Sevala-matti (*Mactra corbiculoides* Desh.) tinted a deep violet colour within, is equally common in the same localities; its smooth shell is distinctly trigonal in outline, usually about 30 mm. in length, with deeply concave valves which are thus able to give accommodation to a body relatively much larger than is contained within the shallower valves of the Kakkamatti. Its colour is most distinctive; externally a bluish-grey with purplish blue colouring showing through at the umbo and usually another similar colour band within the margin; internally the whole surface is characteristically tinted violet. When partially bleached, the colour fades to a warm pink, whence the local name of *Sevala matti* (red matti). Like all Mactrids a portion of the ligament is contained in a centrally placed deep pit or fossette within the hinge and immediately under the umbo (Fig. 9).

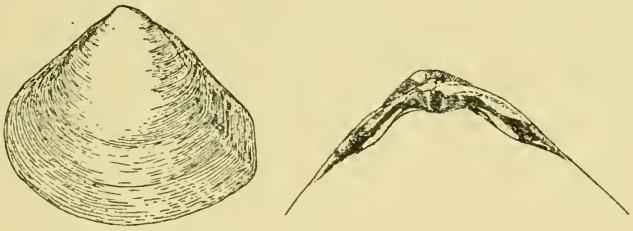

FIG. 9.—SEVALA MATTI (*Mactra corbiculoides*).
Inner view of hinge on the right.

A handsome inflated form of Tapes (*Tapes ceylonensis* Sow.), called *Vazhukkumatti* in the neighbourhood of Pāmban is fished with the foregoing. It has a superficial resemblance to the backwater clam *Meretrix casta*, being about the same size, shape and colour (Fig. 10); it differs however in having pale radiating bands of darker tint on each valve running from the umbo to the margin and instead of having

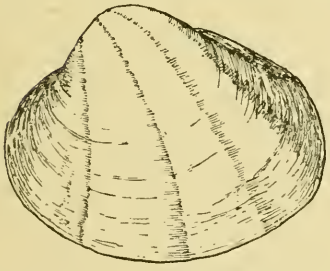

FIG. 10.—VAZHUKKUMATTI (*Tapes ceylonensis* Sow.).

a very small pallial sinus it has one well-marked, deep, and angular Average length 44 mm.

Fresh-water Mussel (Lamellidens marginalis Lamk.).

Although this common Indian species, identical with the text-book type so well known to biological students under the name

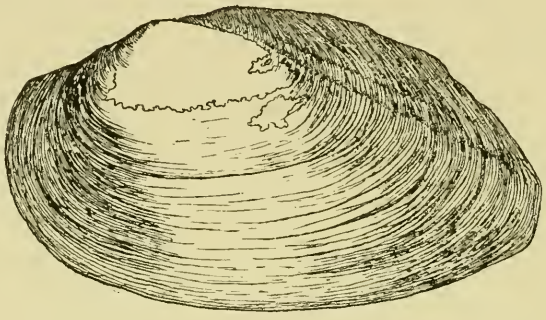

Fig. 11.—Lamellidens marginalis, var. corianus (Lea).

of Unio, is very widely distributed throughout the Presidency, it finds little favour as food. Only low castes care to eat it, but in Ganjām, Tinnevelly and some other districts considerable quantities are consumed when obtainable in abundance.

Both in Ganjām and Vizagapatam districts, the valves are used extensively as instruments for peeling mangoes. To prepare one a hole is made in the convex umbonar region by rubbing this part of a valve—usually a right one—upon a stone till a hole of the right size is obtained; to use the peeler thus formed, it is grasped in the hand with the hollow side towards the palm, and then one edge of the hole is used to peel off strips of skin. The advantage claimed for this implement over a knife is that the mango does not become stained from contact with steel.

It seems probable that the valve of a fresh-water mussel, having a large hole in the centre, figured in Bruce Foote's "Catalogue of Prehistoric and Protohistoric Antiquities," Madras, 1915, under the number 234–129, from Narsipur-Sangam, Mysore, is a mango scraper of this kind, and not part of a shell necklace as surmised by the author named.

This species, although its shell is usually too thin to be of any use in pearl button manufacture, sometimes produces pearls in considerable quantity of fair value. Occasionally they are offered in the Surada Bazar (Ganjām); these are obtained from a great irrigation reservoir in the neighbourhood wherein these mussels flourish, growing to a length of about three inches. The pearls have a reddish tint and less lustre than those from the marine pearl oyster.

GASTROPODS.

Compared with bivalves, gastropod molluscs are of restricted and purely local importance. None seem to be used as food on the Malabar littoral and one only upon the Coromandel coast. Only on the Ramnad and Tinnevelly coasts are several species used to any extent. Neither is the list a long one, limited as it is to the common chank *(Turbinella pyrum)*, the five-fingered chank *(Pterocera lambis)*, the olive *(Oliva gibbosa)*, the turban shell *(Turbo margaritaceus)*, as the ones in common use, with *Strombus*, *Conus* and *Murex* occasionally. The reason is that, with the exception of the common chank and the olive, few gastropods are found in quantity outside of Palk Bay and the Gulf of Mannar; on the Malabar coast, except rarely and very locally, no species abounds in shallow water, and the same may be said of the shores of Vizagapatam and Ganjām.

The Sacred Chank (Turbinella pyrum Linn.).

Tamil—*Sangu* (சங்கு), Tinnevelly and Ramnad districts; *Palsangu* (பால்சங்கு), Chingleput district.

The common or sacred chank, fished in hundreds of thousands for sale to the shell-bangle workers of Bengal, is the most abundant large Gastropod in the Presidency. It brings in a large annual revenue, now amounting to close upon half a lakh of rupees (net) to the Madras Government, and promises to yield a largely increased sum as the organization of the fishery progresses.

As an article of food the flesh has come into local prominence only since the great famine of 1877 when the families of Parawa chank divers of Tuticorin first made systematic use of it. On the run home from the fishing grounds, the divers extract the foot and head region from the shell, using a strong iron skewer for the

purpose. The whole of the glandular tissue in the "tail" of the mollusc is left within the shell. The part extracted is chiefly muscular tissue and carries the large horny operculum. This meat, called *sangu sathai* (சங்கு சதை), is collected in little palmyra leaf

Fig. 12.—The Sacred Chank (*Turbinella pyrum* Linn.). ×¾.

baskets and taken home as soon as the shells have been handed over to the Government officers. In preparing it, the flesh is boiled, cooled, and then, after pulling off the operculum, cut into thin transverse slices which are sun-dried. In this condition they keep indefinitely—hard and horny slices looking like very thin chipped potatoes. In cooking, the slices are fried in ghee or gingelly oil. The quantity consumed must be considerable, for at Tuticorin—where alone a systematic use of the flesh is made—the number of shells so treated amounts to an average of over 250,000 yearly. The bulk of the flesh is consumed by the divers' own families; any surplus is readily saleable within the limits of the caste; none is

ever seen in the markets. The value of the flesh is 12 annas per measure.

In the chank fishery carried on off Rāmēswaram a small quantity of the shells are treated in the same way by Muhammadan divers, who saw some of the Tuticorin men treating the shells thus at the 1915 fishery and who are now beginning to use the flesh similarly. As yet comparatively few chanks have their flesh extracted at Rāmēswaram but the practice will probably gradually become general as a taste for the article is acquired.

Fig. 13.—Egg capsule of the Sacred Chank. × ⅔.

The Pattanavars of the Pulicat fishing hamlets occasionally catch chanks in their thûri nets; the village youngsters are said to be fond of the flesh, eating it after boiling. So few shells are found that the flesh has no market value.

The operculum (Tamil, *naganam* or *navanam*, நாகனம், நாவனம்) of the chank has considerable value, being in demand for use as a glue in the composition of incense sticks. Large quantities are collected from the shells at Tuticorin and Rāmēswaram and sold at the rate of from Re. 1–2–0 to Re. 1–6–0 per pound.

At Rāmēswaram some of the Muhammadan divers make a speciality of this work; they go round during the time of counting and gauging the shells, tearing off the opercula of all those that they can get permission to handle. They use a pair of home-made flat-nosed pliers for the purpose.

For a description of the Chank and its varied uses see "The Sacred Chank of India," constituting Bulletin No. 7 of the Madras Fisheries Department (Government Press, Madras, 1915).

THE FIVE-FINGERED CHANK (PTEROCERA LAMBIS Linn.).

Tamil—*Aiviral sangu* (ஐவிரல் சங்கு), Ramnad district.

This species of Pterocera, the most common of the genus, is very abundant in the faunistically rich shallows of the south-western angle of Palk Bay. From low water to two fathoms, this shell is often numerous, particularly along the coast between Pāmban and Tondi. Some are collected by the shore people wading in the sea at low tide, but the great majority are taken either by the Kadayan and Muhammadan bêche-de-mer divers or accidentally in nets set for crabs, whereof many miles length are shot daily during the season. The shells serve a variety of purposes; as food they are broken open and the flesh extracted, and used for curries; as net sinkers they have the "fingers" broken off, the shell perforated and then are tied at intervals along the ground rope of nets; by burning, whitewash lime is made; lastly they are used as octopus traps. To fit them for the last-named use, the apex of each shell is broken off together with the fingers, and are then attached at intervals of 5 or 6 feet along a rope to which as many as 30 shells may be thus fastened. A number of ropes are tied end to end and laid in shallow water overnight; when raised next morning a number of small octopus are found sheltering in the cavities of the shells. These are used as bait when lining for such fish as seer, parai, dogfish and rays. Hundreds of these shell-trap lines are in use on the Ramnad coast from Devipatam northwards. In Japan a device on the same principle is used for a similar purpose; in place of *Pterocera* shells, the Japanese use narrow-necked vase-shaped earthenware pots, tied at intervals by the neck to a strong line.

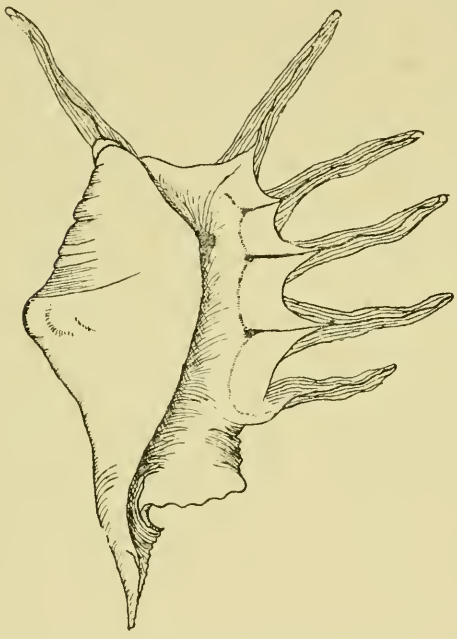

FIG. 14.—THE FIVE-FINGERED CHANK (*Pterocera lambis* Linn.).

THE TURBAN SHELL (TURBO MARGARITACEUS Linn.).

Tamil—*Nathai* (நத்தை), Pāmban.

This small species of Turbo, allied to the well-known mother-of-pearl shell called "Green Snail" in trade, is found in abundance on the surf-washed rocky shoals found here and there on the coral reefs near Pāmban. The island women collect the shells

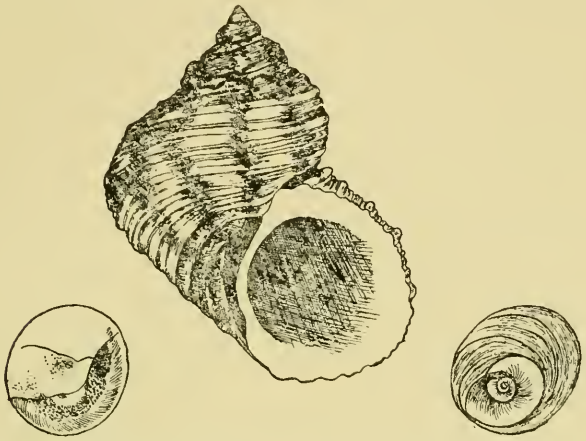

FIG. 15.—THE COMMON TURBAN SHELL *(T. margaritaceus)* WITH OUTER AND INNER VIEWS OF THE OPERCULUM. × 1.

during spring tides when the shoals uncover for a short time; they employ all the available minutes in turning as many stones as possible, this being the favourite habitat of Turbo. The flesh is used in the same way as that of the cockle-clam.

Besides the value of the flesh, Turbo is esteemed for its operculum. This is a stout, disc-shaped stony body, flat on the inner surface, strongly convex on the outer; it serves as a defensive stopper when the animal is attacked, the soft body being retracted wholly within the snail-shaped shell and the aperture closed by the hard body of the operculum. All sorts of shells and marine objects are stocked in several booths within the main entrance to the Rāmēswaram temple, for sale to the thousands of pilgrims who travel thither from all parts of India, and among these objects the opercula of Turbo find place. The best ones are retailed at 8 annas per hundred, sea-worn ones collected on the beach at considerably less. The island women (Valayans chiefly) get about 8 annas per measure from the Rāmēswaram shopkeepers. The Tamil name for them is *ambiliman* (அம்பிலிமான்) signifying the disk of the moon.

The Top Shells (Trochus spp.).

Tamil—*Thalappaikatti* (தலப்பாய் கட்டி), Pāmban.

Several species of top-shells but chiefly *T. radiatus* Gmel., are occasionally fished along with Turbo in the neighbourhood of Pāmban. The flesh is not valued owing to the small size of the shells and the difficulty of extracting the body. Sometimes when there is nothing else to be had for their curry and Trochus is abundant, Valayan women collect the shells at low water, and cook the flesh in the same way as that of Turbo. A small incentive to the collection of these shells is the fact that the shell dealers in Rāmēswaram temple give two annas a measure for the shells.

The Olive Shell (Oliva gibbosa Born).

Tamil—*Kovauji* (கோவஞ்சி), Palk Bay ; *Sangu* (சங்கு), Pulicat.

This small spindle-shaped shell, noted for its high polish and the beauty of its marbled colouring, is very common about low-water level on all sandy shores on the east coast ; it is rarely seen in Malabar. On the Coromandel coast it is extensively used as food by the Pattanavar or sea-fishermen caste. On the Ramnad coast it has less importance as a minor food item ; while utilized, chiefly by Valayans, in the same way as other shellfish whenever found, it is in some cases sought for separately on account of the price the shells fetch when sold to the shell dealers in Rāmēswaram temple, who give an anna per hundred for the shells.

Fig. 16.—The Common Olive *(Oliva gibbosa)*. × 1.

On the Coromandel coast, the chief collecting season is at the times of spring tides during the fine weather period from February to April. Towards the end of the ebb tide Pattanavar women and lads then engage in the search, from about extreme low water to a depth of a couple of feet. They find the shells by turning the sand over with the foot or in the case of those in the uncovered sand by marking the trail made as the Olive travels about.

The Pattanavars boil their catch in fresh water, extract the flesh and then either use it in their curry or fry it in oil.

The size of these Olives runs from 50 to 60 millimetres in length. In the sea-fishing hamlets or kuppams in the neighbourhood of Pulicat Lake, their shells, with those of Donax, contribute no inconsiderable bulk to the kuppam kitchen middens there accumulating.

Rock Whelks (Purpura rudolphi, Lamk. and P. bufo, Lamk.).

Tamil—*Par attai* (பார் அட்டை), Pamban.

These shells measuring about 50 millimetres in length, are found along with Turbo on the shingle and stone strewn shoals of the islands and mainland of Ramnad district. They are not

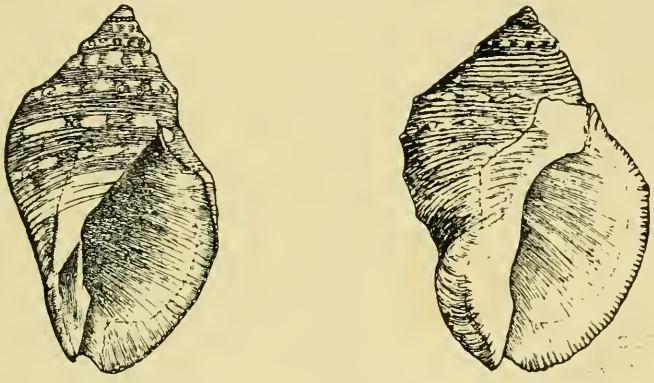

Fig. 17.—Purpura rudolphi, Lamk., and Purpura bufo, Lamk. × 1.

specially collected, but any found during the search for Turbo are kept and cooked along with the latter by the Valayans who are the chief inhabitants of the Ramnad islands. Other castes are said not to eat these species.

Strombus and Conus.

None of these shells is ever regularly collected for food purposes, but on the Ramnad coast and the adjacent islands, the poorer shore people when gathering other shells take any they find and cook them with the rest.

The shells of the mottled Wing-shell (*Strombus canarium*) have some value independent of food purposes; large numbers are used annually at Kilakarai by shell-ring makers in their trade. These men who are all Muhammadans, pursue the most primitive methods, such as we can understand prehistoric men employing. The two ends of the shell are first broken down by means of a hammer

and chisel and then the resultant middle section is ground down laboriously upon a stone.

Except a hammer, a chisel, and a file used to smooth the edges, no other tool is employed. These rings, known as *sangu modiram*,

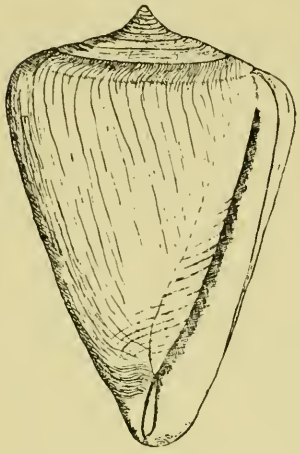

FIG. 18.—A CONE-SHELL.

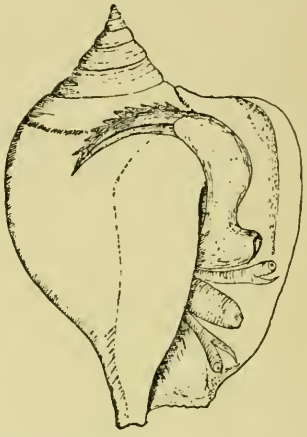

FIG. 19.—THE MOTTLED WING-SHELL (*Strombus canarium*). × 1.

are extensively used as finger rings throughout the Tamil country as a specific against skin eruptions. In the Malabar and South Kanara districts certain classes of the poor population—Pulayas, Holayas and some Mukkuvans—use these rings in the making of necklaces for their women and children.

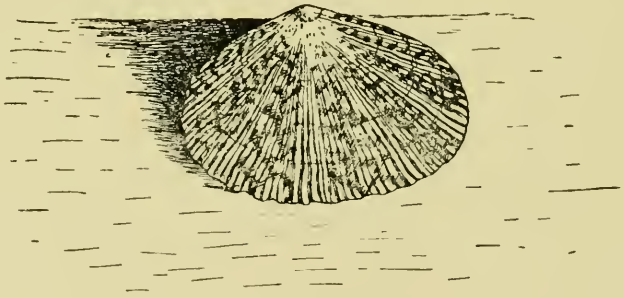

FIG. 20.—A LIMPET ATTACHED TO A ROCKY SURFACE.

LIMPETS—(PATELLA spp.).

Tamil—*Unai* (உளை), Covelong, Chingleput district.

Wherever fairly smooth-surfaced rocks are exposed to surf

action between tide marks on the east coast, small limpets can usually be found. The rocks off the beach at Covelong, Chingleput district, are where I have seen them most numerous and there some of the poorer among the fisher people are accustomed to collect them for food. They are also to be seen on the rocks at Mandapam but no use seems to be made of them. The available suitable ground is too limited in this Presidency to permit this shell-fish to be put to extensive use.

Fresh-water Snails (Ampullaria and Vivipara).

Tamil—*Nathai* (நத்தை) for Ampullaria; *Umachchi* (உமச்சி) for Vivipara.

Large brown water-snails belonging to the genus *Ampullaria* are abundant in fresh-water marshes and ponds, as well as in paddy fields where they are often seen in great numbers and up to 1½″ diameter as a usual size. Throughout the Presidency they are collected after the paddy has been harvested and the fields run dry, by low caste women who use them to help out their ordinary meals. They are also used medicinally for sore eyes.

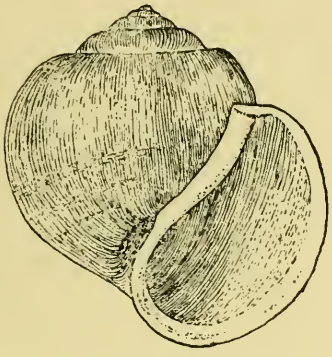

Fig. 21.—The brown water-snail (*Ampullaria*). Natural size.

Seale states that in Manila and other Philippine towns large quantities are sold at an average price of 1½ anna per kilogramme.

Vivipara, another common but much smaller fresh-water snail, is also used to some extent as food in the Southern Tamil districts, being gathered in ponds, marshes and paddy fields in company with the larger Ampullaria. It is less esteemed than *nathai*, being both smaller and less succulent.

In preparing all fresh-water snails for food, it is essential to remember that care should be taken to cook them thoroughly, as some species in other countries are known to harbour larvæ of certain parasitic worms which cause dangerous diseases if they pass alive into a new host. In England and elsewhere the small pond-snail *Limnaea* is often infested with the young of the liver-fluke, a parasitic flat worm which causes much disease among sheep

when pastured in marshy meadows, whilst in Egypt a common and dangerous human disease induced by the presence of the parasitic worm *Bilharzia*, has recently been traced to the infection of another fresh-water snail belonging to the genus *Planorbis*. Parallel cases of disease transmitted to man through the agency of fresh-water snails have not yet been traced in India, but whether this is due to lack of attention to this possible source of disease or whether to the excellent custom prevailing generally throughout India of eating no animal food except it be cooked, it is not yet possible to say.

CEPHALOPODA.

Octopus, Squid and Cuttlefish.

Three species of Cephalapods have considerable economic importance in the Presidency but the locality where they are caught in abundance, is much circumscribed, and is limited virtually to the confines of Palk Bay. The two most abundant and most valuable forms belong respectively to the genera *Loligo* and *Octopus*, a medium-sized species of Squid (*Loligo*) being caught in great quantities in nets and by jigging, while a small species of *Octopus* (*Polypus*) is taken largely in shell traps. The third is a Cuttlefish (*Sepia*) not caught in abundance but of some value for its "bones" which are thrown ashore in considerable quantity. A trade opening probably exists for the introduction of methods of cure which will enhance the selling value of these highly nutritious and tasty marine products.

Besides these, at least two other kinds of Octopus are occasionally caught and eaten.

The Common Squid—(Loligo sp.).

Tamil—*Kundal Kanavai* (கூந்தல் கணவாய்), Rameswaram Island; *Ekki Kanavai* (சக்கி கணவாய்), west coast of Palk Bay.

The species represented under these vernacular names is the only large Squid found in abundance in Palk Bay. Shoals appear in shallow water off Rameswaram Island about April and during the month preceding the burst of the monsoon—about 15th June—the shoals reach their maximum, and then consist of immense assemblages of individuals sheltering under the lee of the land, to feed upon the smaller fry that seek similar shelter, and to deposit their egg capsules among the weeds common in the places favoured.

Two methods of fishing are employed, the one a wholesale netting in which thousands are caught at a haul; the other, where the skill of the fishermen is exercised in catching the Squid singly by means of a jigger.

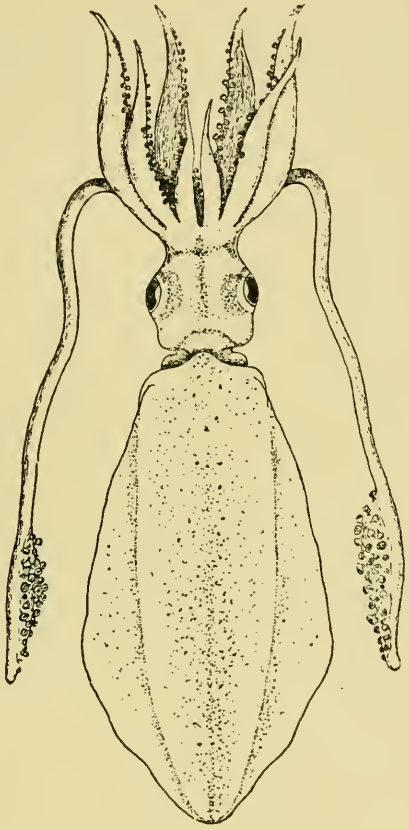

FIG. 22.—THE COMMON SQUID. × $\frac{1}{3}$.

The first method is largely practised in Rameswaram Bay during the early part of the south-west monsoon; a seine is used having a large close-meshed bag in the centre, with long wings and with wing ropes closely set with strips of palm leaf (olai) to serve as scare lines, and so to herd the Squid into the bunt of the net. In the season there are usually four sets of these Squid seines—called *olai-valai* locally—in daily use at Rameswaram. When shoals are about catches may occasionally range up to 5,000 a haul. The bulk of the Squid caught are sold to fish runners who come from Pamban

at rates varying from Re. 1–12–0 to Rs. 2–8–0 per 100; the balance is consumed locally. When demand is weak and little is sold for consumption fresh, the Squids are sundried and sold eventually at Ramnad and other inland markets at about Rs. 3 per 100.

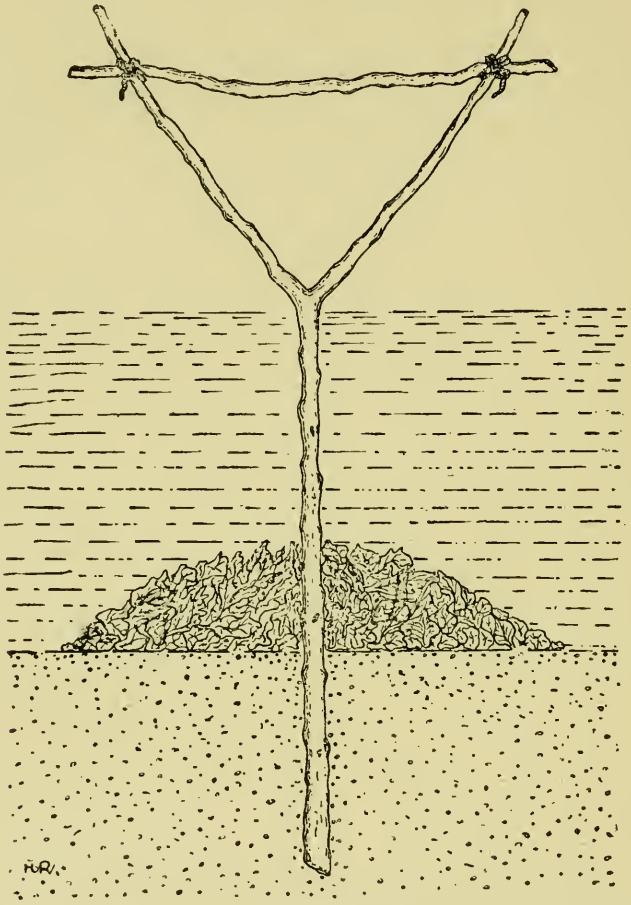

FIG. 23.—FISHING PLATFORM USED AT RAMESWARAM WHEN JIGGING FOR SQUID.

Jigging for Squid is practised chiefly for home requirements by individual fishermen, who sun-dry any surplus they may have. This method is largely employed along the northern coast of Rameswaram Island, especially at Rameswaram and at Arya-kundu, near Thangachimadam, during the Squid season. To carry it on the fisherman erects a small outlook in shallow water—a form of machan (Fig. 23). The main portion of the structure consists of a stout bifurcated tree branch of Y-shape, the main stem

embedded firmly in the sea-bottom; across the ends of the two arms which project upwards several feet above the surface of the water, a strong pole is fixed horizontally to serve as a rest for the fishermen. The height of this seat above the sea-bottom is generally about 6 feet; 8 feet at the utmost. A pile of leaves is tied or anchored at the foot of the staging to attract the squid; the fisherman when ready, takes his stand on his outlook armed with a slender pole 12 to 15 feet long, furnished at one end with 5 or 6 stout hooks set grapnel fashion, thus (Fig. 24):—

Fig 24.—Squid Jigger.

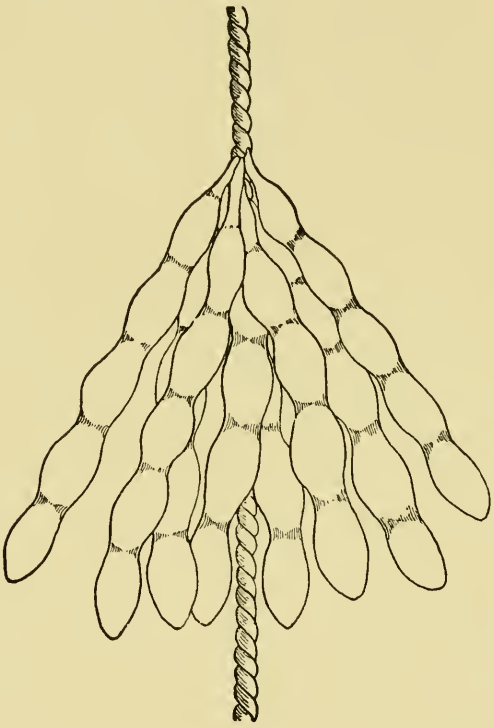

Fig. 25.—Egg Capsules of a Squid attached to a submerged rope. Half natural size

Watching the bottom intently, the fisherman waits till he sees a squid approach to investigate the heap of leaves. As soon as it comes within range he cautiously moves his jigger into a favourable position and with a deft jerk imbeds the jigger hooks in its flesh and lifts it from the water. The reason why the Squid seek shelter amid the leaves set as a lure, seems, on the part of the female, to be for the purpose of laying her eggs therein, as she requires such

objects whereto to attach the great gelatinous candle-like capsules in which the ova develop (Fig. 25). The male is said to follow the female at this time, so that sometimes both fall a prey to the fisherman's jigger. What is not used or sold immediately is split open, washed and sundried; it makes a very clean and attractive-looking product.

This method of fishing is generally carried on in the morning, the fisherman occupying his outlook for four or five hours at a stretch. The branched post employed is cut generally from a babul thorn, the one tree that manages to thrive well on this sun-scorched sandy coast. At Rameswaram there are often as many as one hundred of these Squid machans in use.

Cuttlefish (Sepia).

Tamil—*Ottu Kanavai* (ஓட்டு கணவாய்), Palk Bay.

Cuttlefish are far less abundant than Squid in Palk Bay and are not the object of any special fishery, though some are occasionally taken in the casting net (*vichchu valai*) and in drift net and shores seines. Their "bones" are however thrown up in large quantities on the southern and south-western shores of Palk Bay during the north-east monsoon, and at this period of the year, numbers of Kadayan women scour the littoral in their search. After long continued northerly winds, the supply is often very abundant during November and December at Rameswaram, and after easterly winds (March and April) at Tirupalagudi and Tondi; a woman can collect several hundreds in a day. These are eventually sold to agents of Kilakarai, Devakottai and Pamban merchants who tour the coast to buy up the stocks available. A gunny bag full of cuttle bone of all sizes fetches from ten annas to Re. 1-4 0; sometimes they are sold by number and

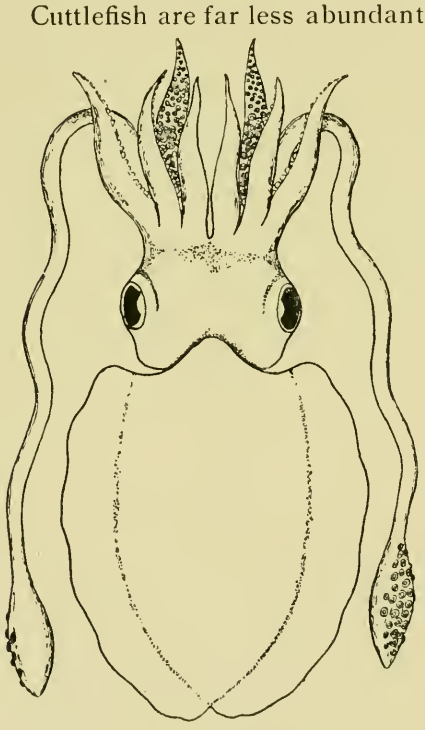

Fig. 26.—A Cuttlefish (*Sepia*). × ½

size, the price varying from two to eight annas per 100; a common price is one pie (one-twelfth anna) for large bones and two or three per pie for small ones. A regular price cannot be said to exist; rates vary with the needs of the seller and of the purchaser.

On the south coast of Rameswaram and other islands near Pamban, cuttle bones come ashore during the south-west monsoon but not nearly so plentifully—only about one-tenth the quantity—as they do on the north coast of Rameswaram during the north-east monsoon. In a single season the collection of cuttle bones from Rameswaram Island alone amounts to from 10 to 14 cwt., a quantity representing a very large number of bones. The total Indian export amounts to a considerably larger quantity. Several fishing villages on the mainland, such as Morepanai near Uppur, report an annual collection of 20 to 50 bags each per annum. A considerable quantity is also obtained from the Travancore and Malabar coasts; most of this is exported through Tuticorin. From Kilakarai 14½ cwt. were shipped to Colombo during 1914–15.

A considerable demand exists in Europe for cuttle bone, especially for large sizes. From information received from a London dealer in this product, it is readily saleable there at £2–16–0 per cwt. delivered c.i.f. in London, in the case of large selected bones (8 to 12 inches long and above) and £1–8–0 per cwt. for bones of mixed sizes from 12 inches down to small pieces of about 2 to 3 inches, with at least half the bulk between 6 and 12 inches long. Care should be taken to ensure the bone being perfectly dry when packed, in order to prevent mould appearing.

Palk Bay fishermen cherish the belief that cuttlefish cast their bones annually at the season when they are thrown ashore in great quantity. Strangely enough no shoals of cuttlefish are ever caught in nets—only stray individuals; that large shoals do abound is evident, for it occasionally happens after a severe storm that very great numbers are thrown up on the beach, dead but quite fresh. The village women collect them, cure them in the sun and take to market where they generally find a ready sale.

THE SMALL DEVILFISH (OCTOPUS sp.).

Tamil—*Sa Kanavai* (சா கணவாய்), Rameswaram Island; *Pey Kanavai* (பேய் கணவாய்) and *Sangu Kanavai* (சங்கு கணவாய்), west coast of Palk Bay.

This is a small species caught solely for use as bait. It swarms in the weedy shallows of Palk Bay. It is in keen demand by line

fishermen as it makes the best bait known to them—its flesh firm and not easily pulled from a hook and its odour tempting beyond measure to the fish sought after.

To capture it, long lines are prepared having some hundreds of a large Pterocera shell (*P. lambis*) attached at short intervals, after having the apices and "fingers" broken off. These lines are sunk on the bottom in places which this Octopus frequents, and when lifted each morning many of the shells are tenanted by Octopods that have sought concealment therein.

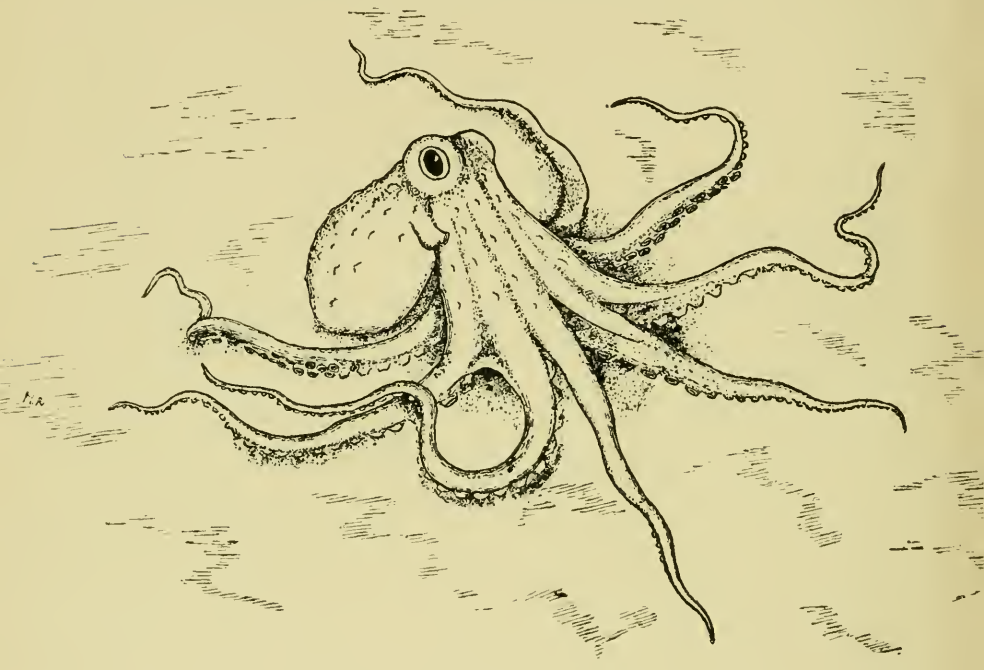

FIG. 27.—THE SMALL DEVILFISH (*Octopus* sp.). Natural size.

Every village on the Ramnad mainland fronting Palk Bay possesses these octopus lines, and the number of octopus thus caught is very great indeed; the industry is an important one both in itself and because of the dependence thereon of the line fishermen, who find it difficult to get other suitable bait if it be wanting. This bait fishery is said to have existed at Rameswaram a decade ago, being given up when line fishermen abandoned this occupation, because, according to some, their boats being small and unseaworthy, fishing on the offshore banks was found to be too dangerous for these timid and unenterprising souls.

The number of shell traps used on a Devilfish long line usually run to upwards of 800. The crew of a line-fishing boat on the Tirupalagudi coast consists normally of five men, and each of them when he joins brings 5 or 6 short lines, each armed with from 25 to 30 shells, say a total of 150 to 180 per man, or a grand total of 25 to 30 lines carrying 700 to 900 shells in all. The lines tied end to end are laid out in a depth of 2½ to 3 fathoms of water, one end being buoyed with a large wooden float. Each morning the fishermen haul the lines and the attached shell-traps; so common are these small Devilfish that a considerable number of the shells are tenanted by them. Enough for the day's requirement of bait are removed, the line and its traps are relaid, and the fishermen proceed to bait their fish hooks with the captured octopus.

Every third week or thereabouts the lines are brought ashore and dried for a day to prevent rotting and then relaid for a further active period. At the beginning of the rainy season, lines are brought ashore, dried, and stored till the rains are over.

The most frequent name used for this creature is *Pey Kanavai*—literally "Devil squid"—the exact equivalent indeed of "Devilfish," the popular English name of the Octopus. The fishermen say they call it so, because of the devilish restlessness which it exhibits when taken from the water and the impression of concentrated malignity which its appearance and habits make upon them. Often on the Pearl Banks, I have come across small ones hiding in empty pearl oyster shells; they certainly do appear uncanny in their activity when attempting to escape; they dash hither and thither like some great fleshy spider of the sea, their arms writhe and twist with a speed the eye cannot follow; small as these are, the play of the little suckers closely set over the arms is unpleasant on the skin and to restrain them is as difficult as to hold a globule of quicksilver. Their eyes, huge for their size, are too human to be pleasant, and it is no wonder the fishermen think they have a devil's malevolence and ingenuity. They credit them too with a great deal of sagacity; amongst other clever tricks attributed to them, is that when they enter an empty shell, they are careful to close the entrance with a shell or piece of stone, as a screen against their enemies, the crabs. I cannot vouch for the truth of this story, but I think it may quite probably be true. They are also said to sham death when they realize that they are finally cornered.

The Poisonous Devilfish (Octopus sp.).

Tamil—*Visha kanavai* (விஷ கணவாய்).

Another species of small Octopus called *Visha kanavai* (literally "poisonous kanavai") is occasionally caught in shell traps in the relative proportion of one or two per cent to the number of the *Pey kanavai*. The fishermen make no use of it as they say no fish will take it as bait. I have not seen it alive, but from dead specimens it is seen to be a slender-armed Octopus, looking very much like an immature example of the larger Octopod called *Kundal kanavai* at Tirupalagudi.

The common belief is strong that it is endowed with marked poisonous qualities; when caught it is usually thrown overboard at once. The fishermen say that it is equally active as the *Pey kanavai* and if it has the chance will fasten on a man's leg or foot and bite through the skin. The sensation is likened to the sting of a scorpion and if a remedy is not quickly applied, the limb will swell and a feeling of giddiness will be experienced. The accepted remedy is a curious one; betel juice is expectorated upon the place or chunam (slaked lime) smeared over the wound as soon as possible. Then, when shore is reached, jaggery (palm sugar) is rubbed over the place bitten and a dog being brought, is induced to lick the jaggery off; in so doing, it is believed that the poison will also be removed. In spite of this curious and complicated treatment, the effects of the poison are said sometimes to be experienced for several months afterwards, the usual complaint being that of a continued swelling of the leg bitten.

Although the bite of the *Visha kanavai* is esteemed so poisonous, the flesh is considered innocuous and when accidentally brought ashore with other species, it is cooked and eaten together with them.

UNUTILIZED SPECIES.

Besides the kinds of shellfish above enumerated, which are themselves only partially utilized for food supply on the Madras coasts, there are several others, often occurring in considerable abundance, that are not eaten in this Presidency although they are all wholesome, highly nutritious and freely used as food in other parts of the world. This difference in habit appears to have a racial significance, for, of the Asiatic races, it is those of Mongolian stock which exhibit real and keen liking for such food. The Dravidians of India appear to have no innate liking for shellfish;

wherever they do use it, such employment seems to spring either from an acquired taste or to be due to the compulsion of poverty directing attention to a cheap source of food supply. In China, Japan, the Philippine Islands and generally throughout the Malay Archipelago, the markets of all large seaboard towns abound daily with many kinds of shellfish, and in numerous towns, such as Manila, the labouring classes depend largely upon this source for their daily food. It may be noted here that, so far as I know, there are no poisonous species found on the Indian coasts; all are edible and when gastric troubles do occur it is due almost entirely either to individual and abnormal susceptibility or intolerance, or, much more frequently, to unsuitable methods of cooking whereby the food is rendered tough and difficult of digestion. Light steaming is on the whole the most digestible method of preparation for bivalves; they may either be eaten without further preparation or else stewed for a prolonged time with appropriate flavourings. To those with good digestion, they may be made into more high seasoned dishes, such as curries, or fried or baked in butter or ghee (preferably) or in vegetable oils.

The Pearl Oyster (Margaritifera vulgaris).

Tamil—*Mutthu chippi* (முத்து சிப்பி).

Hitherto the local pearl oyster has been esteemed solely for the pearls it occasionally produces. At a pearl fishery the feverish eagerness of the search for these prizes is so intense that the food value of the flesh is forgotten. This however is very considerable, for it is both tender, well-flavoured and highly nutritious; in these qualities it is about on a par with the Scallops (Pectinidæ) of Europe and may appropriately be cooked by the same methods.

The shell grows to a sufficiently large size to accommodate a body ample enough to repay a cook's attention. The size usually attained is 75 millimetres in length by an equal depth from hinge to ventral margin. The glandular tissues (gonads and digestive glands) are greatly developed in healthy individuals and make the flesh highly nutritious and tonic. Its food value may be considered fully equal to that of the edible oyster; it is however rather richer in fat content and in the cooked condition sweeter and more like in flavour to the scallop. It is most excellent whether scalloped, stewed, baked, or curried, and in my opinion is the finest of Indian shellfish. If ever a fish cannery be established on the shores of the

Gulf of Mannar, I believe that in those years when pearl oysters are poor in pearls though abundant numerically, the canning of their flesh would prove a remunerative undertaking. For details of the anatomy, see Herdman and Hornell in *Ceylon Pearl Fishery Reports*, volume II, page 37.

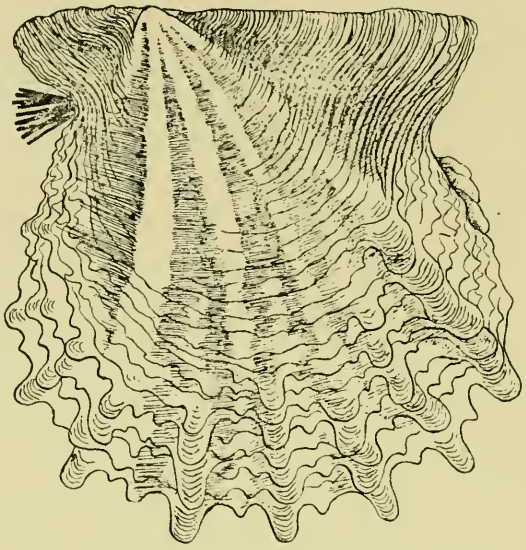

FIG. 28.—THE INDIAN PEARL-OYSTER. Natural size.

Its permanent habitat in Indian waters seems to be the shallows of Palk Bay where extensive beds, comparatively thinly populated, exist in several localities. The pearl banks in the Gulf of Mannar, both on the Indian and Ceylon sides, are not continuously occupied by pearl oyster deposits; their occurrence is irregular and roughly cyclic, short series of productive years alternating with longer series of blank years when the beds are either very poorly stocked or absolutely barren. These banks appear to be repopulated at intervals by spat from the permanent or mother beds in Palk Bay. When this happens, the resultant beds are often exceedingly extensive, aggregating even as much as a hundred square miles in area in some years. The quantity that comes to maturity is comparatively small, but even then a favourable year may yield anything up to 40 or even 80 millions of oysters during a fishery. To harvest pearls the fishers must wait till the oysters are over three years old, but if they are required for canning purposes they may be fished profitably when two years old. At this age they are very delicate and more tender than when they are a year or more older.

Pinna.

Tamil—*Akku* (ஆக்கு).

In shallow water from half to five fathoms, a large species of Pinna is sometimes found in great abundance. In some places, as for example in the south-west of Palk Bay, they occur so close inshore that bathers run great risk of cutting their feet on the projecting knife-like edges of these shells. The common species is our largest bivalve, running to a length of 13 inches. It is of

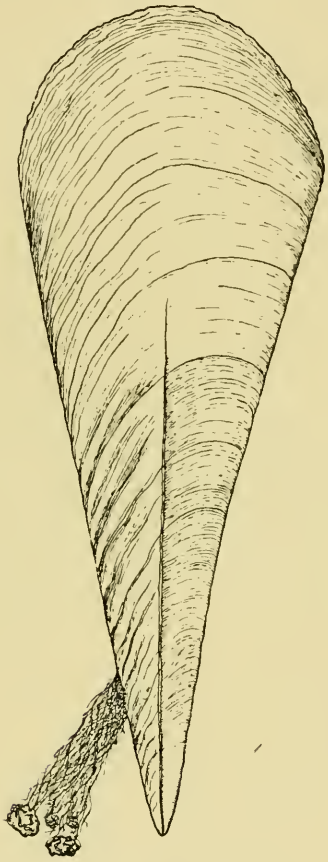

Fig. 29.—The Common Pinna. × $\frac{1}{3}$.

elongated wedgeform, and lies buried in sand with its apex downwards, showing an inch or two only of the wide ventral margin projecting above the bottom. In the 1905 Ceylon pearl fishery, several millions of pearl oysters were found in one area utilizing the projecting edges of living Pinna shells as foothold.

No one eats Pinna on the Indian coasts, but in China it is in great demand, and in Japan large quantities of the great adductor muscles, circular discs of white flesh measuring 1½ to 1¾ inch in diameter, are cut out and dried for export to China, in the same manner as they treat the foot of Haliotis (the *abalone* of the Californian coast).

Razor-shells (Solenidae).

Tamil—*Pul ākku* (புல் ஆக்கு).

In shallow sandy bays, several species of Razor-shell are common but the size is much smaller than the average attained by British species. They are long scabbard-shaped shells living buried upright just beneath the surface. In most countries they are highly esteemed as a tasty marine delicacy, but no one collects them in India, as no demand exists.

Ark-shells other than Arca granosa.

Besides *Arca granosa*, there are two other related forms which though not used at present, are potential sources of food supply.

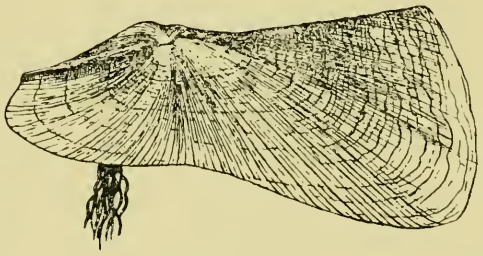

Fig. 30.—The twisted ark-shell. (*P. tortum.*) × ¾.

They are the hairy ark-shell *(Barbatia barbata)* and the twisted ark-shell, *Parallelopipedum tortum*, so called because whilst the opposite sides are roughly parallel, none of the angles are right angles. Both of these are fairly numerous in certain parts of Palk Bay and were shellfish more widely appreciated by our Indian populations they would find their place in the market supply.

The habitat of both is between the 4½ and 6 fathom lines on a bottom of dirty muddy sand. They do not form continuous beds but occur scattered singly over large areas. Their shells often give foothold to pearl oysters on the banks north-east of Tondi.

The Weaving Mussels (Modiola spp.).

Several medium-sized species of the weaving mussels exist in our seas and in Palk Bay; one is so abundant that I have seen several square miles of sea-bottom covered continuously with a carpet of their shells, felted together in a tangle of byssal threads. The average size is not too small and were there any demand, tons of them could easily be dredged in Palk Bay. The larger ones are excellent eating, while the smaller would make, if dried and pulverized, an excellent manure.

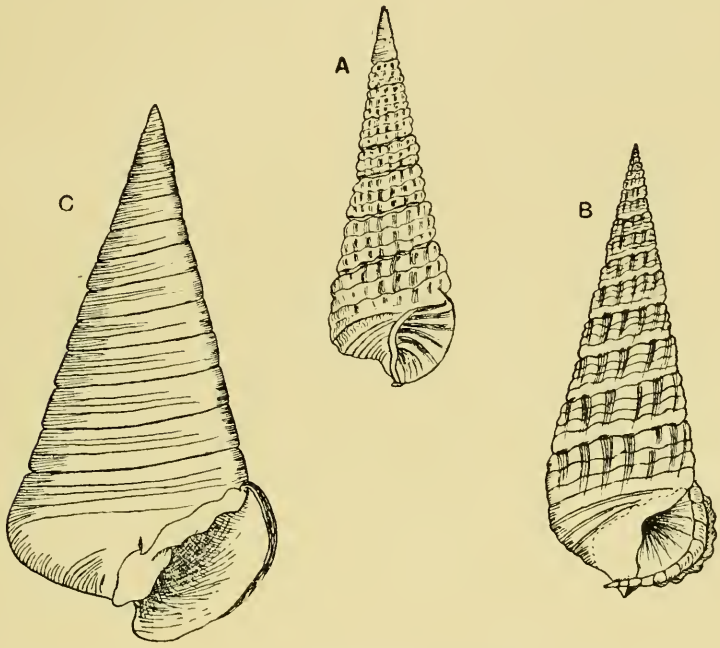

Fig. 31.—Horn shells { A. *Potamides fluviatilis*. × 1½. B. *Potamides palustris*. × ⅚. C. *Potamides fuscum*. × $\frac{7}{10}$.

Horn Shells (Potamides spp.).

Except for lime-making the great Horn shells, *Potamides (Telescopium) fuscum* and *P. (Pyrazus) palustris*, often to be found in abundance in the mangrove swamps of the Kistna and Gōdāvari deltas, are not utilized for any purpose. Among the Malays both are esteemed as food; they throw them on wood fires, and when they are sufficiently cooked, break off the top of the spire and suck the animal out through the opening.

In the Philippines they are regarded as good food and are frequently sold in the local market. Numerous other related smaller forms (*Cerithium* spp.) are also sold, the price averaging 5 centavos per kilogram, or about 6 to 7 pies per pound (200 centavos =one U.S. Dollar).[1]

THE KNOBBED WHELK (MELONGENA VESPERTILIO Lamk.).

This large whelk-like shell is not uncommon in saltwater lagoons and shallow bays on the east coast, where it attains a length of from 8 to 10 centimetres. Its pretty, regularly knobbed shell, deep chestnut in tint, is often to be seen along the margin of Ennur and Pulicat backwaters, but in many of these cases the actual inhabitant is a hermit crab which has appropriated the shell after the death of the original owner.

Melongena is eaten freely in the Malay Archipelago according to Seale;[2] it is also to be seen exposed for sale in the Suez markets, being common in the canal and neighbouring lagoons.[3]

[Since writing the above I find that the Knobbed-Whelk is caught in considerable numbers along with the common chank (*Turbinella pyrum*) in thūri nets off the Tanjore and South Arcot coasts, and that the flesh of both is eaten after boiling by the Pattanavar villagers. Indeed the fisherfolk of these coasts are accustomed to boil and eat the flesh of any large gastropods they may catch in their nets; among others the great Tun-shell (*Dolium*) and the equally large Melon-shell (*Melo indica*) when caught--both are rare--are placed in boiling water, the flesh extracted and eaten, and the empty shells sold to the chank-shell lessee, who sells them as curiosities in Madras and other large towns. The shells of the knobbed-whelk are used in lime-burning to make whitewash lime.]

LAND MOLLUSCS.

For some reason which I have failed to penetrate, land molluscs are not utilized for food except in the single instance of the great king-snail, *Ariophanta basileus*, a denizen of the Cochin teak forests, which is occasionally used by the semi-wild tribes that live on forest produce. With this exception none of the Indian land-snails

[1] Alvin Seale—"Notes on Philippine Edible Molluscs" *Philippine Journal of Science*, Vol. VII, No. 4, p. 279, Manila, 1912.

[2] Alvin Seale, *loc. cit.*, p. 279.

[3] Cambridge Natural History, Vol. "Molluscs", p. 102

are eaten so far as I can learn. This is not due to any lack of species of adequate size, if we take the apple-snail, *Helix pomatia*, so highly esteemed by the ancient Romans and the modern French, as a standard, or the more common English garden snail *(H. aspersa)*, utilized very abundantly by the French when the former species is unobtainable. In Madras gardens two clean-looking snails are found, smaller indeed than *Helix aspersa*, but still large enough for culinary use; one is the single-banded *Ariophanta ligulata*, the other the two-banded *A. biserialis*. Larger than these are several species found in the Anamalai, Palni, Nilgiri and other hill tracts. Among the more notable are the Ariophantas. *A. basileus*, already mentioned as occasionally eaten in the Cochin teak forests, is also found in the Anamalai and Nelliampathi hills; it is a magnificent species often measuring 2½ inches in diameter. *A. maderaspatana*, a smaller species, inhabits the Palni hills, while another, *A. kadapaensis*, fully equal in size to *Helix aspersa*, is found in the Anamalais, together with *Helix ampulla* of about the same dimensions. *A. semirugata* is another fair-sized snail found in the Coimbatore and adjacent districts. Finally from Mysore comes a slightly larger snail, *Cyclophorus nilghericus*. It will be noted that most of these are hill species, found chiefly in the jungle tracts that clothe the lower slopes and creep up sheltered ravines. Taken generally land-snails are not plentiful on the plains, being replaced there by the pond-snails *(Ampullaria* and *Vivipara)* found in abundance wherever paddy cultivation is of importance.

In dry sandy tracts where babul thorns abound, especially in Tinnevelly and Ramnad districts, a small white *Helix* is often exceedingly numerous, but although one would expect this to be of some food importance at least in times of famine, I cannot trace any utilization even in years of direst distress. A *mamul* prejudice prevails against the use of any land-snails.

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MADRAS FISHERIES DEPARTMENT.

A NEW PROTOZOAN CAUSE OF WIDESPREAD MORTALITY AMONG MARINE FISHES

BY

JAMES HORNELL, F.L.S.,

Government Marine Biologist, Madras.

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A NEW PROTOZOAN CAUSE OF WIDESPREAD MORTALITY AMONG MARINE FISHES*

BY

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GOVERNMENT MARINE BIOLOGIST, MADRAS.

Widespread fish mortality is a well known phenomenon on the Malabar and South Kanara coasts; its recurrence yearly along certain stretches of the coast line is regular, though its intensity varies within wide limits. In certain seasons it is local in occurrence and affects only a few species close inshore; at others, by no means of annual or regular occurrence, many and diverse kinds are involved, and it may affect large shoals both close in and at several miles distance from the land.

Until the present, I believe no detailed investigation of this phenomenon has been attempted; neither has any satisfactory explanation been given, although various hypotheses have been advanced. My attention has been given to the subject intermittently for several years past, but till last year I was never able to spare the time necessary for a continuous investigation at a period coincident with the occurrence of the phenomenon.

Before detailing my own observations and the conclusions arrived at, I may note that all Malabar fishermen whom I have questioned agree in saying that every year after the passing of the rainy season and the subsidence of the south-west monsoon, if there be a continuance of fine weather for a week or ten days, with plenty of sunshine, and a weak coastal current, the water inshore becomes turbid and discoloured, brownish or reddish in tint; that this water has such poisonous effects upon fish that large numbers become affected and eventually die. The first effect of the poison is to make the fish sluggish and at this stage, as I have myself seen, boys and men crowd to the shore and make great hauls of the dying fish. Fishermen further state that if favourable conditions continue, the colour of this foul water changes and becomes distinctly redder, and emits a stench so strong as to be

* A paper read before the Zoological section of the Indian Science Congress held at Bangalore, January 1917.

almost unbearable; when this occurs they state that the poisonous influence increases and fishes of kinds not affected during the first onset of the poison, die and are cast ashore. They agree fairly generally in stating that sardines are seldom affected in any quantity, but some men have told me that on two or three occasions, separated by long intervals, they have seen widespread sardine mortality from this cause; in these cases the sea was covered for miles with dead and dying sardines in enormous multitudes.

The men's explanation of the cause of this foul and poisonous water, which they term indifferently *Karanir* (shore-water) and *Sen-nir* (red-water) in North Malabar, and *Karanir*, *Sennir* and *Kedunir* (bad-water) at Calicut, is simple and unvarying. One man's statement as taken down at the time is characteristic of all; according to him, *Kedunir* is the product of freshwater brought down by rivers; it runs into the sea and as it will not mix with sea-water, it stagnates in the heat of the sun, and gradually becomes stinking and of a red (*sic*) colour, something like brandy or tea without milk. Like brandy, too, it intoxicates all fish that drink it and after a time they die. All fish that enter the *Kedunir* first become stupefied and then die; if the *Kedunir* beats upon rocks the fish and crabs that live there will also die. Even big bamin (*Polynemus* spp.) and Kora (*Sciaena* spp.) have been affected, but those that usually die are small fish such as young kora (jew-fish), manthal (soles), malan (mullet) and etta (catfishes), also crabs. Sardines die during certain seasons but generally they are careful to avoid coming into this *Kedunir*. From this belief that the latter is consequent upon the mingling of river with salt water, is due the name sometimes applied of *Irunir* or "double water."

Among Europeans various hypotheses have been current, based, so far as I know, upon no solid ground of serious investigation—mere guesses in fact. Among the more plausible of these may be mentioned (*a*) suffocation by excessive mud in suspension in the water, and (*b*) the emission into the sea by rivers of large volumes of putrid water derived from the pits wherein coconut husks are soaked for long periods preparatory to the extraction of fibre, and also by the emptying or overflowing of rice fields in which vegetable matter is allowed to putrefy for manure.[1]

My investigation disproves all these theories. That of the fishermen is easily negatived, for in every case (and they were

[1] Day, F. "Land of the Perumauls," p. 417.

many) where *Karanir* and *Kedunir* were indicated to me, the specific gravity of such water was found to be fully as high as that of ordinary sea-water in the vicinity. The density of the water in which the dying fish were found on several occasions was also that of normal sea-water. As to mud being a cause, that was early seen to be out of court as no mud was in suspension in any *Kedunir* pointed out by fishermen nor in that in which fish were found dead and dying. On the contrary this mortality takes place not in rough weather when mud banks are disturbed, but in calm sunny weather when the sea is usually free from sediment. The fish most commonly found dying at the beginning of the phenomenon are bottom fish such as soles and cat-fish, and these I have found by direct experiment can live and thrive in water in which such mud is kept artificially in suspension. There remains the theory of foul water from rivers; this is negatived (*a*) by the lack of foul odour in the water when it first occurs, (*b*) by its density being that of nearly normal sea-water, (*c*) by the absence of vegetable debris in suspension in the water called *Kedunir* or *Sennir*, and lastly, (*d*) by the fact that it is as frequent in bays into which no great river empties as in those where one does.

After this short review of facts and theories, I shall now state my own observations and conclusions.

My first experience of poison water was in November 1908 when on a fishery cruise along the west coast of the Madras Presidency. On that occasion I was so fortunate as to witness one of those specially widespread cases of mortality which affect whole shoals of fish and cover comparatively great areas, but which are said by fishermen to be infrequent and not of annual occurrence.

In this instance great stretches of water off the Mangalore coast were thick with dead sardines in various stages of putrefaction. The area affected was over fifteen miles in length and lay generally from one to two miles off shore. No organisms except bacteria were present in quantity in the water. The stench was intolerable. Details are recorded in Fisheries Bulletin No. 4.[2]

The next occasion when I met with poison water was on 8th November 1912, when my attention was drawn to a dirty and malodorous condition of the water lapping the beach at Calicut. The colour of the water was distinctly brownish, a clear yellowish

[2] Hornell, J. "Report on the Results of a Fishery Cruise along the Malabar Coast," *Madras Fisheries Bulletin*, No. 4, p. 101 : Madras, 1910.

brown not unlike brandy but with a suggestion of olive in it. This the fishermen told me was *Kedunir*, a water that would kill fishes if it were thicker as it would become if calm weather and a hot sun were to continue two or three days longer. I saw no fishes or crabs dead then but as I was busy with canning experiments at the time I had no opportunity to search carefully. I did however examine the water microscopically and to my surprise found it to be full of myriads of brownish yellow Euglenids to the virtual exclusion of all other organisms. The Euglenids were filled with very granular protoplasm, had a large colourless nucleus, and contained many minute dirty yellow chloroplasts and usually several fairly large oil globules. Unlike the typical Euglenid of fresh water, this species had no red eye-spot. A long flagellum emerged from a well marked pit at the blunt end of the body. The most remarkable feature of the organism was seen, however, after the water had stood for half an hour. By that time, many of the Euglenids had sunk to the bottom of the vessel and were seen to have become embedded and semi-quiescent in a delicate colourless jelly of relatively enormous bulk, obvious to the naked eye as it formed a distinct dirty brownish yellow layer at the bottom equal to fully one-twelfth the volume of water present. In those individuals which had not settled to the bottom, a well defined firm cuticle could be observed, but in those in the jelly no sign of this was seen ; the surface of the body was rough and almost wart-like through the protuberance of granules of the body substance. Hence it is clear that the jelly-like matrix in which the Euglenids were embedded had been formed at the expense of the cuticular layer.

At this stage the matter remained till September 1916 when I was able to visit the Malabar coast with more favourable opportunities for the study of this problem.

In the beginning I made Cannanore my headquarters. To my disappointment I was told on arrival that an occurrence of fish mortality had already taken place and had passed away. As nearly as I could fix the date it had occurred during the last week of August. According to my informants, there had then been a week's break in the monsoon with calm sea and a sunny sky. *Karanir* had appeared after a few days and coincident with it, many crabs and soles had died. Rain and strong wind set in again shortly after and the mortality ceased. For several days after my arrival no

sign of *Kedunir* appeared, but on 20th September I sighted several bright red patches moving northward at about half a mile from the shore. Procuring a boat, the patches were found after a long search, a mile off shore and samples obtained. The water of the patch was found to be 1023 S.G. at 80° F., that of normally coloured sea-water close by being identical. On examining the samples, the organisms colouring them were found to consist of a nearly pure gathering of *Noctiluca*; in the containing jar they kept close to the surface and there formed a dense layer nearly a quarter of an inch thick, coloured a distinct pink. Fishermen called it *Punkara* or "flower water" and asserted that it was a sign of the early reappearance of poison water (*Sennir*, *Karanir*, or *Kedunir*). While alive this scum of *Noctiluca* gave out a strong and unpleasant odour; with death, the smell decreased markedly.

For some days thereafter heavy rain and overcast skies prevailed and no sign of poison water appeared, then a transient interval of fine weather supervened, and on 25th September news was brought to me that *Karanir* had appeared and that dead crabs and fish were coming ashore. Sure enough I found the beach south of Cannanore littered with dead crabs (chiefly *Neptunus pelagicus*) but the *Karanir* had disappeared with a sudden change of weather. The specific gravity of the shore-water when examined was found to be 1023 at 85° F. and contained a considerable number of greenish *Peridinians* of two species (*Gymnodinium* spp.) and a smaller number of brownish *Euglenids*. The former I thought might possibly be the cause of the poison water, as "red-water" containing hordes of a brownish Peridinian (*Gonyaulax polygramma*) is known to cause widespread mortality in Japan among fishes and molluscs, and as I had seen Peridinian red-water at Tuticorin causing limited mortality. The fishermen, however, asserted that the true *Karanir* had disappeared and subsequent events showed that Peridinians are not (at least usually) the cause of fish mortality on the Malabar coast.

A few days later we had another spell of fine sunny weather and on 2nd October *Kedunir* was again reported, and this time I was able to watch the whole sequence of events from the commencement. As soon as I saw the water lapping on the beach I recognized the olive-brown water I had seen in 1912 at Calicut; examination showed it to be swarming with the same brownish yellow Euglenid to the exclusion of all else except a

comparatively few green Peridinians and a very few Diatoms. Dead crabs (chiefly *Neptunus pelagicus*, with a few *Thalamita*, *Scylla*, *Neptunus sanguinolentus* and *Matuta*) were abundant in the wash of the tide and along tide-mark and crowds of men and boys were busily engaged in netting and spearing crabs and fish in the shallows. The fish were chiefly soles *(Plagusia bilineata)* and small jewfishes *(Sciaenids)*, together with smaller numbers of catfishes, *nonthal (Sillago)* and *Koruppan (Platycephalus)*. Several fairly large shore seines were being operated and these made great captures. Two *peruvalas*, each used from two canoes nearer the rocks at the south end of the bay, made even greater hauls and in these were to be seen larger jewfishes and numerous large crawfishes *(Panulirus)* and many *Neptunus*; the catches, however, consisted principally of soles and I was told that several of these large nets had been torn the night before because of the immense weight of soles captured. All the live fish seen were evidently in a state of exhaustion, varying in degree from a slight lack of ordinary vigour to one of marked stupefaction or coma. In the latter the gills had the appearance characteristic of asphyxiation and in the case of the crabs, the stomach and intestine were empty. Over the whole area affected, the water was olive-brown, the sea being calm with no apparent current within the bay. The mortality continued during the next three days, the affected area moving slowly northwards along the shore in response apparently to an eddy-drift within the bay. With this continuance of the poisonous condition, an extension of the mortality became apparent. On the first day a few *Hippa* were seen thrown up but upon the third day, thousands of dead of the two species found here, together with a few of the rarer *Albunea*, accumulated on the level beach adjacent to the Old Town. The great majority were dead, but a few were seen feebly and unsuccessfully trying to burrow. Littoral molluscs were also greatly affected; *Donax cuneata* was thrown up dead in quantity near the mosque, and still larger numbers were seen washing to and fro on the bottom. A small *Pholas* and some *Mytilids* were also seen dead in considerable quantity, together with occasional dead individuals of *Donax scortum*, a large *Mactra* and other bivalves.

Along with the stranded *Hippa* were found over a dozen individuals of the fine Alcyonarian, *Cavernularia obesa*, still alive but evidently in an advanced stage of asphyxiation, as the polyps

were all in a state of expansion and did not retract or respond readily upon irritation.

Wherever rocks are found within the bay, it was notable that many small hermit crabs were found washed up dead and dying in the vicinity. It was most significant that the majority of these had no sheltering shell. They had obviously become so enfeebled and stupefied as to be unable to retain a grip on the columella of their house and had slipped out and been carried ashore. The few still within shells, *Trochus* and *Turbo* chiefly, were either dead or could be pulled out without resistance. This instance, together with that offered by the dying off of *Hippa*, *Donax* and *Cavernularia*, appears to furnish the clearest evidence of the correlation of this mortality with the presence of the Euglenid-infected water, as all these are not vagrant forms such as the swimming crabs and fishes generally; the latter might conceivably have been poisoned elsewhere and have drifted ashore into the Euglenid water, but such a possibility is impossible in the case of *Cavernularia*, Hermit-crabs, *Hippa* and burrowing Molluscs.

On the fourth dav the mortality had decreased markedly; men no longer found it profitable to net the inshore water and the number of Euglenids had sensibly decreased. This change coincided with an alteration in the weather; the wind had freshened and it was clear that the poisonous water was being dispersed by the roughness of the sea and the stronger inshore current. The next day conditions had become practically normal. Later in the month (9th October) similar Euglenid-infected water was seen at Calicut accompanied by mortality amongst soles and *Hippa*; the extent of the trouble was however insignificant and it appears that the open character of the coast, with the absence of any embayment, is an adverse and limiting condition against severe concentration of poison water along the shore in this particular locality.

In the bays in the neighbourhood of Quilandi and Tikkotti, a few miles north of Calicut, more favourable physical conditions prevail and from 9th to 16th October the presence of Euglenid water and concurrent fish and crab mortality were noted, less severe but otherwise similar in character to that which occurred at Cannanore earlier in the month.

The specific gravity of the olive-brown affected water on 2nd and 3rd October when the mortality was most intense was 1026 at 81° F.; water taken on October 3rd a quarter of mile from the shore, which

contained comparatively few Euglenids, was slightly higher, being 1026·5 at the same temperature. On 5th October when the water in the bay had begun to clear, a distinct rise in the specific gravity of the inshore-water was noticed, being 1026·5. Off shore-water was undoubtedly coming in and driving out the foul water, for coincident with the rise in density, the number of Euglenids were now comparatively few, their place being taken by several species of diatoms common to ordinary sea-water on this coast.

The Euglenid-infected water noted at Calicut and Quilandi from 9th to 16th October, ranged in density from 1025 to 1026·5 at 82° F. The Euglenids appear to flourish equally at the higher as at the lower density.

On the evening of 16th October a break of weather occurred, the fine sunny conditions of the preceding week giving place to heavy rain and cloudy sky. On 17th October sea-water from near the shore showed an almost entire disappearance of Euglenids and a fall in density to 1024·5 at 80° F. No further swarms of Euglenids were noted during the remainder of the month which was characterised by a continuance of rainy weather.

There can now be no question that the prodigious multiplication of Euglenids in shallow water on the Malabar coast causes extensive recurrent local mortality amongst the inshore fauna; whether other organisms also cause mortality and the precise way in which stupefaction and death are brought about remain uncertain.

With regard to the former question, it is to be noted that never before has fish mortality been attributed to the superabundance of flagellate infusorians such as the *Euglena* above described; all other observations point either to the group of Peridiniales or Dinoflagellata or to the cysto-flagellate *Noctiluca* as being the organisms involved in those cases where fish mortality has been traced to the occurrence of the phenomenon termed "Red-water" in other parts of the world. The phenomenon is by no means unique. Nishikawa has recorded interesting cases from Japan [3] while Gilchrist has recorded others from South Africa.[4]

Nishikawa records that in September 1900, "streaks and patches of brownish yellow water emitting an unpleasant odour

[3] Nishikawa, T. "Gonyaulax and the discoloured water in the Bay of Agu," *Annotationes Zoologicæ Japonenses*, Vol. IV, part 1, pp. 31–34, Tokio, 1901.

[4] Gilchrist, J.D.F. "An enquiry into fluctuations in fish supply on the South African coast," *Marine Biological Reports* (Union of South Africa), No. 2, Cape Town, 1914.

were observed by fishermen in the Bay of Agu . . . As this 'red tide' (*sic*) is said to have been in former times highly destructive to the beds of the pearl oysters which form one of the principal productions of the Bay, great alarm was felt for the molluscs. Fortunately on 28th of the month, a heavy storm arose and cleared the waters of the bay so that very little damage was actually done." When Nishikawa went to Agu to investigate, the discolouration of the water had almost disappeared and in consequence his enquiry was incomplete. He was able to show however that the discoloured water was due to the presence of a superabundance of a Peridinian, *Gonyaulax polygramma* Stein, so numerous that he estimated the Peridinian population of a drop of this water at from 800 to 3,000 at the densest area. Nishikawa remarks that "usually the appearance of discoloured water is accompanied by a great mortality of fishes, molluscs, and shrimps. According to the observation of a pearl-oyster culturist, in the latter part of August 1899, large streaks and patches of yellowish-red water floated about with the tide in the Bay of Toba. Fishes which were kept in baskets floating on the surface of the sea were damaged by them. Fishermen easily caught the littoral fishes by spearing, for the fishes had become very sluggish in the discoloured water. Even Haliotis seemed to suffer."

Owing to the incompleteness of his observations Nishikawa was uncertain whether the presence of the peridinians *per se* was the immediate cause of the mortality. He noted as significant that other forms of plankton abundant in neighbouring uncontaminated water were practically absent from the discoloured water, a fact similar to that which I noticed in the euglenid water off Malabar. He inferred that water fitted for the propagation of peridinians and unsuitable for the existence of the usual plankton is probably also unsuitable for other fish life, or else the dead bodies of enormous numbers of peridinians sinking to the bottom and putrefying there, may eventually become injurious to other organisms.

Mr. Nishikawa, whom I had the pleasure of meeting when in Japan in 1907, informed me further that when "red water" runs into a bay fishes float to the surface stupefied. He added that in Omura Bay, near Nagasaki, the farmers of the district welcome the appearance of this poison water as they can then catch quantities of fish with ease.

He mentioned that truly red or pink water is also found in Japan, also yellow water. The former is due to a superabundance

of *Noctiluca*, the latter to myriads of diatoms, chiefly *Rhizosoma*; he held that neither exercise harmful effects upon fish life even when in vast superabundance.

This latter opinion is directly opposed by Gilchrist who states that [5] :—

"Red water is a phenomenon observed not infrequently in South African seas. It consists of masses of red-coloured water sometimes a mile or two in extent, at other times occurring only in small patches. In False Bay it may be seen usually several times during the summer months, and presents a very remarkable appearance, being frequently of an almost blood-red colour. It consists of multitudes of *Noctiluca*, normally present in sea water nearly everywhere. At certain times, however, they increase enormously in numbers, when they can be seen to consist of minute egg-like bodies, which in mass present the conspicuous red colour referred to. Such crowding together of these minute organisms appears to pollute the water, for when examined microscopically most were found to be dead . . . It has been observed that fish seem to avoid the red water and fishermen do not care to fish in its vicinity. It is said that mullet caught in it, decay very quickly, becoming quite decomposed if left ungutted overnight. One or two instances are known in which fish and other marine animals have been killed apparently by such polluting of the water. I am indebted to an old resident in Saldanha Bay for some particulars of such an occurrence at that place. He stated that on one occasion, the only one in his experience, about the year 1907, the bay, which is almost landlocked, became filled with red water, known locally as 'flower water.' At the time there had been a north-west wind for some days previously. The fish in the bay were seen floating belly upwards in a disabled condition. Some of them were cast on shore in quantities at the end of the bay, in such numbers that they were 'taken away in cartloads.' Even the shell-fish, such as Mussels (*Donax serra* probably), Klip-koes (*Haliotis*) were killed off in large numbers, apparently on account of the presence of large quantities of decaying organic matter."

Gilchrist is also of opinion[6] that when diatoms occur in vast swarms, under certain circumstances they may decay and cause the death of fishes by suffocation.

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[5] *Loc. cit.*, p. 17.

[6] *Loc. cit.*, p. 19.

Prior to my Malabar experience last year, my attention had been drawn to this subject by a small occurrence of bright red water at Tuticorin. In this case the colour was due to the presence of immense quantities of a bright pink peridinian of very minute size. A few small fish were seen dead where this water settled, but the swarm passed away quickly and was of too small extent to cause serious harm. This bright red water (not the brownish-yellow of the Japanese "red-water") emitted an intolerable stench, a blend seemingly of sulphuretted hydrogen with the smell of decomposing fish oil. Accompanying this red water was a dense scum of a sage green tint due to the presence of vast quantities of an extremely large species of a green *Paramoecium*, which appeared to be preying upon the peridinians.

From this experience and remembrance of Mr. Nishikawa's Japanese observations, I began the Malabar investigation on the hypothesis that the cause of fish mortality was to be sought in an undue abundance of some peridinian. As my first samples of water taken at Cannanore, from a place where discoloured water with accompanying fish mortality had been seen a fortnight previously, contained considerable numbers of two species of yellowish green Peridinians (*Gymnodinium* spp.), my belief was strengthened but, as above detailed, I had to abandon this in face of the repeated conjunction of euglenid-infested water with widespread mortality of fishes, crustaceans and molluscs within the same area.

The immediate cause of death in the case of fishes, crabs and shell-fish caught in the foul water seen periodically on the Malabar coast is undoubtedly some form of suffocation in the wide sense of a poisoning of the blood of the animals concerned by some asphyxiant present in the surrounding medium—the water of the sea. The symptoms are distinctively those of this form of death—the gills dark and livid and movements sluggish. Especially marked was the comatose condition of affected crustaceans. Exactly how the asphyxiation is brought about is uncertain; it may either be by exhaustion of oxygen in the sea water or by poisoning due to the excretion of waste products on the part of the euglenids or it may be semi-mechanical in cases where bottom-loving animals have come within an area where vast masses of the euglenids have settled to the bottom and have there passed into the jelly-forming resting stage. The first suggestion is the least likely, as the euglenids are possessed of chloroplasts and are more

likely to set free oxygen in quantity than to absorb it. On the other hand poisoning of the water by the excretions of myriads of individuals and by the decomposition products liberated through the death of the short-lived generations of these organisms is sufficient cause for much of the mortality noted; the third, or mechanical factor, has, I believe, particularly harmful influence upon burrowing and sedentary organisms, as these are unable to escape its blanketing effects.

Fishermen aver that the phase of mortality which I witnessed last year is by no means the climax; they hold that with a continuation of favourable weather—calm seas and an abundance of sunshine—the trouble increases, being characterized by a thickening of the water and emission of an intolerable stench, entailing an extension of widespread death among larger fishes and occasionally among shoals of sardines. As I have not had an opportunity to watch this further progress and enhancement of the trouble, I cannot say definitely how it is caused. I have, however, seen the ultimate result of such an extended death in the case of sardine shoals as already mentioned.[7] I am inclined to the opinion that these more extensive instances of mortality owe their origin primarily to the same cause as induces the more limited and localized cases described above, that is, to the superabundant multiplication of immense swarms of euglenids. The extension of the area covered and the increase in the numbers of fish involved may be explained by (*a*) simple increase in the extent of the euglenid swarms, reinforced by (*b*) a progressive intensification of the evil influence due to the putrefaction of ever-increasing quantities of dead fish. Many of the patches of putrefying sardines seen in November 1908 off Mangalore (*loc. cit.*) were reduced to mere frothy ochreous yellow bacterial scums. These patches were often as much as half a mile in length by half that in width. The atmosphere was horribly contaminated by an intolerable stench of oily decomposition; the water contamination must have been intense. Healthy fish wandering into these areas of decomposition quickly became affected, rushing hither and thither aimlessly and in evident distress, coming gasping to the surface and finally turning on their sides and dying. With each accession of material to the putrefying mass, the area of contamination continues to

[7] Hornell, J., *Madras Fisheries Buleltin*, No. 4, pp. 101–105.

increase gradually till rough weather supervenes when the mass becomes broken up and scattered and thus ceases to be a focus of death.

So far as my observations go, they favour the view held by Mr. Nishikawa already referred to, that *Noctiluca* is not an active agent in causing fish mortality. I have seen it in great profusion colouring considerable areas bright pinkish red both off Cannanore and in Palk Bay and in neither locality did I find any associated with fish mortality nor would any of the fishermen accuse it of evil influence ; they agreed in declaring it to be innocuous. At Cannanore it is called Punkara (" flower-water "), while at Tirupalakudi it is known as Valkarai (" stain-streaked water ").

On several occasions both at Cannanore and at Calicut, there were great numbers of *Noctiluca* present, especially near the surface ; in one instance only did I find it reproducing actively by sporulation and it is noteworthy that in this instance the individuals were ingesting the accompanying euglenids in great numbers.

The masses of jelly-cased resting euglenids which accumulate on the bottom form an important food source of the oil sardine *(C. longiceps)* and hence possess an important economic value as an offset to the mortality they occasionally entail among fishes.

I should mention that unlike *Noctiluca* and Peridinians generally, these euglenids do not emit any appreciable bad odour while alive.

Incidentally this enquiry furnished a satisfactory explanation of a curious incident in the siege of Cannanore in 1507 that has long puzzled historians. In the year named, the Portuguese, not long arrived in India, were besieged in the fort of San Angelo by the Kolattiri Raja and the Zamorin of Calicut with an army of 60,000 Nayars. After a lengthy siege the garrison were reduced to the greatest straits and lived on lizards, rats, cats and other animals. " On the 15th August, however, a miraculous event occurred, seemingly in answer to the prayers of the besieged to the Queen of Heaven, whose feast day it chanced to be, for the sea sent forth shoals of crabs and prawns, and the garrison again lived in plenty." So says Logan in his " Manual of Malabar,"[8] an explanation which is undoubtedly correct, in spite of the fact

[8] Logan, W., *Malabar*, 2nd edition, page 316, Madras, 1906.

that the date given is earlier than that at which dead fish and crabs usually appear. This apparent discrepancy vanishes when we remember that the date given is old style: to bring it into agreement with the present calendar ten days must be added, thus bringing the date to 15th August; last year abnormally fine weather prevailed during the last week of August, with the result that kedunir and dead fish and crabs were noticed at Cannanore during that week, thereby reproducing almost to the day the phenomenon of 1507.

Addendum.

The above account was written in November 1916 immediately after my return from Cannanore in October. I brought away a small bottle containing a quantity of euglenid jelly with a view to ascertain the odour it would give out when dead and undergoing decomposition. The jelly has refused however to decompose. The bottle has stood upon my desk from October till now (17th March 1917), and under the microscope the jelly shows almost precisely the same appearance it did when first the free-swimming euglenids passed into this resting condition. The one difference I note is that the chloroplasts are now distinctly more green than when the jelly-stage was entered upon; the colour then was a distinct olive brown in the mass, now it is a dark olive green. The gelatinous matrix seems also somewhat reduced. I propose devoting attention during its next seasonal appearance to a further elucidation of its life-history.

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MADRAS FISHERIES DEPARTMENT.

A STATISTICAL ANALYSIS

OF THE

FISHING INDUSTRY OF TUTICORIN

(SOUTH INDIA)

BY

JAMES HORNELL, F.L.S.,

Government Marine Biologist, Madras.

Report No. 3 (1917),

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BY

JAMES HORNELL, F.L.S.,
GOVERNMENT MARINE BIOLOGIST, MADRAS.

INTRODUCTORY.

When I first engaged in fishery duty in the Madras Presidency I found that no adequate data existed concerning the statistical condition of the fishing industry. The only figures available were those contained in the census reports, and those existing in the records of the fish-curing yards conducted by the Salt and Abkāri Department. The former were of little or no use as they dealt only with the numbers of the population engaged in the industry, while the latter took account only of fish brought to the yards for curing—no notice was taken of the fresh-fish trade, which in populous centres is usually the more important branch.

Without a fairly accurate knowledge of the relative value and quantities of the different kinds of fishes caught and of the relative and absolute importance of the methods employed, I felt that no real progress could be possible in initiating new fishing methods or in introducing improvements in existing ones; in other words an investigation upon scientific lines must precede any experimental innovations conducted empirically. Unfortunately the means at my disposal for such an enquiry were so scanty that I had to confine it to a single port in the first instance. That port had necessarily to be Tuticorin where alone I could improvise the necessary organization for the purpose. The enquiry was commenced in October 1911 and was carried on without interruption throughout the ensuing four years.

Those who are acquainted only with the methods employed in collecting fishery statistics in Great Britain can have little idea of the difficulty experienced in organizing and carrying through such an enquiry in India. A British fishery statistician would probably

appoint, in the case of a small port, an agent from the ranks of the fish-trading community of the place, who, for a small fee, would collect daily from the fish salesmen of the port accounts of the fish they had handled, together with such other details as could be obtained readily from the owners of the local fishing fleet and from the carrying companies serving the port.

In an Indian port like Tuticorin anything like this is impossible. There is no wholesale fish market except the beach, there are no companies or large owners controlling each a number of boats, and while there are certainly some fish salesmen and traders, these men seldom or never keep any accounts, and if they did would probably refuse to acknowledge the fact or else would falsify them lest a demand for income-tax should ensue. Worse still, the fish are seldom sold by weight, measure or number. The catch is usually thrown in a heap on the beach and the 'lot' as it lies is sold by auction—the buyers must appraise its value by the eye, and make their bids accordingly. Accordingly the only way to obtain fairly reliable statistics at Tuticorin was to depute two men to attend respectively at the two main fish landing places and to ascertain as best they could the catch of each fishing boat as it was landed and sold. To arrive at an approximately correct idea of the weight in the case of larger fishes, these were counted and average individuals weighed by means of a spring balance; in the case of small ones, the number of standard basketsful were ascertained as best might be, and by reference to the weight capacity of these standard baskets, the weight of the fish was estimated. I cannot pretend that the results are absolutely accurate, but I believe they are fully as reliable as the generality of British fishery statistics. To prevent errors due to the personal equation, the same enumerators were employed throughout, thereby eliminating one very fruitful source of error in such an enquiry. Constant supervision was also employed and wherever possible any exceptional catches were specially tested and verified. The only figures of which I have any reasonable doubt concerning their accuracy are those collected during the first three months; the enumerators were then gaining experience and probably were not so expert in estimating quantities and separating species as they eventually became. Still I see no adequate reason to exclude these particular statistics and I believe that the tables and summaries given below are sufficiently accurate for all practical purposes and

precise enough for the purpose of generalization. Any minor errors there may be, will be consistent throughout the enquiry and the relative accuracy of the figures will be nowise impaired thereby.

In the main I shall use either the local Tamil names or else their English equivalents when these can be employed without danger of misapprehension. To prevent any possibility of confusion, I append a list of the local vernacular names with the English equivalents which I employ in the text and in the tables, together with the scientific name for each species as used by Day in his *Fishes of British India* (1889)—" Fauna of British India " series.

During the four years the enquiry continued, October 1911 to September 1915, the annual wholesale values of fish landed at Tuticorin were respectively Rs. 40,256, Rs. 42,179, Rs. 49,053 and Rs. 45,146 giving an average per annum of Rs. 44,158.

Not to overload these notes with figures I shall, wherever possible, work upon the average annual figures for this period rather than analyse each year separately.

Adopting this principle the average yearly weight and value of the 36 most important fishes are as follows :—

Names.	Weight in pounds.	Value in rupees.
Vālai	213,525	16,681
Sardines	68,114	4,257
Jew-fishes	59,049	5,115
Sea-perches	54,568	4,613
Rock-cod	36,155	3,954
Seer	24,050	4,509
Sea-breams	23,626	2,215
Sharks and Rays	22,840	1,427
Red Mullet	14,893	679
Anchovies	14,486	930
(Gerridae)	10,868	509
Horse-mackerel	9,169	1,145
Whiting	9,041	989
(Chorinemus)	8,412	1,051
Bonito	6,900	862
Cat-fish	6,152	288
(Lactarius)	6,076	759
(Otolithus)	4,748	296
Grunter	3,526	165

Names.	Weight in pounds.	Value in rupees.
Ribbon fish	3,457	108
Barracuda	3,272	409
Indian Herring	2,921	182
Grey Mullet	2,785	261
Pomfrets	2,524	473
Hilsa	2,505	313
(Diagramma)	2,235	209
Trigger-fish	2,130	89
Butter-fish	1,011	125
Spotted Dory	977	91
Bamin	915	114
Dolphin	706	44
Mackerel	631	49
Sword-fish	530	33
(Lobotes)	348	32
Garfish	129	6
Soles	129	6

The values of these fishes are calculated according to the rates given in the table on page 85 and are rather higher than the actual prices obtained on the beach.

Vālai fishery.—From the above it is seen at a glance that by far the most important fishery carried on from this centre is that of the Vālai *(Chirocentrus dorab)*. This fish, the only species of its genus known in Indian waters, is caught in thin cotton drift nets having a mesh of 1¼ inch from knot to knot. So important is the fishery that this net, the one most largely employed here, is termed the vāla valai or vālai net. Each vālai fishing boat carries a fleet of seven nets, each measuring 24 fathoms along the head rope with a depth of about 5 fathoms when set. The upper edge is buoyed with large wooden floats, the lower edge is weighted with small stones and sometimes partly with shells. The nets are never barked, as the fishermen allege that poor catches are made if they be barked. They believe that the brown tint which results makes the nets too readily visible to the fish. As the sea on the fishing grounds is generally very clear, this is probably an adequate reason. I am endeavouring to meet the difficulty by introducing a green preservative dip for the nets, but even on this the fishermen look askance and its utility has not yet been

sufficiently proved to persuade them to adopt it. Being unbarked the nets have a short life, not extending beyond a single year.

The boats used are converted dug-out canoes; the sides are first " spread " or forced outwards by an ingenious but tedious method of wedging, then ribs of naturally grown curve are bolted on and a deep weather board added along each gunwale. The length of vālai boats ranges from 28 to 30 feet. A single mast with a broad low lug-sail is carried and with a strong favouring breeze they can make 5 to 6 knots through the water. Their great defect is the lack of a keel ; being smooth bottomed they have no grip on the water and make far too much leeway when beating against the wind. The one remedy would be to fit them with a centre board or drop keel or better still to instal a small motor and so render them independent of sails.

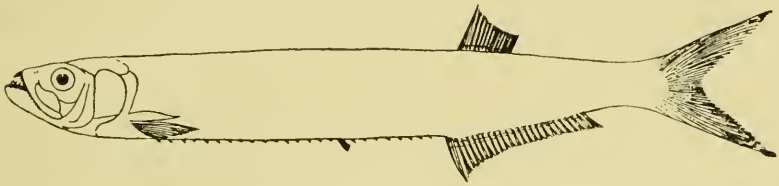

FIG. 1.—VĀLAI (Chirocentrus dorab). × ⅛.

They carry 5 to 6 men of a crew, this large number being necessitated by the frequent need to propel the boat by oars when the wind is adverse or a calm prevails. Fitted with a motor, a crew of 4 men would be ample, while some increase in the size of the boat would be possible, and this in turn would make the boat more profitable, as it would enable a very considerable increase in the quantity and length of nets carried. The vālai is a fish highly esteemed by the Indian public and a great increase in the supply would readily be absorbed by the market at remunerative rates. On the east coast it occupies the place that the herring does in England—a tasty morsel within the reach of the purse of the great mass of the people. Hence I propose to devote special attention in future to the development of this industry and particularly to the improvement of the nets and boats used; the life history of the fish, whereof we know little, is also receiving attention.

Unlike the French sardine and the oil-sardine of Malabar *(Clupea longiceps)*, the vālai does not harass the fishing industry by failing to appear in due season in certain years. There is

considerable irregularity in the catch of any particular month, from year to year, but what is short in one month in a particular year is frequently made up wholly or in part in another month. There are certainly years comparatively poor, but none can be said to be years of absolute dearth ; curiously enough in the four years' statistics here presented, very rich years alternated with comparatively poor ones—in 1911–12 the catch was 269,000 lb. against 185,000 lb. in the following year, succeeded by a splendid total of 275,000 lb. in 1913–14 with the disappointing amount of only 125,000 lb. in 1914–15.

The following table gives month by month the catches made in the four years named together with the average monthly catch in pounds.

MONTHLY catches in lb. of Vālai *(Chirocentrus dorab)* during four years.

Year.	October.	November.	December.	Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Year's total.
1911 ...	5,667	7,909	4,680	1912	25,215	17,366	4,490	8,240	129,598	29,462	18,784	12,522	4,770	26[illegible],703
1912 ...	155	3,076	12,401	1913	21,042	13,851	13,200	36,463	35,418	26,214	19,066	2,133	2,064	185,083
1913 ...	1,991	1,433	2,812	1914	17,716	6,538	8,145	11,451	22,435	176,169	20,214	5,652	513	275,069
1914 ...	594	2,616	3,507	1915	18,162	18,145	4,743	1,551	20,568	12,123	33,857	7,413	1,964	125,243
Average over the 4 years.	2,102	3,759	5,850		20,533	13,975	7,645	14,426	52,005	60,992	22,980	6,930	2,328	213,525

Vālai seasons.—Vālai fishing proceeds throughout the whole year, but except from January to July inclusive (with a break of poor catches in March when the sea is particularly calm and the water crystal clear) fishing is not of much importance; the two periods (*a*) January and February and (*b*) April to July inclusive constitute the true vālai season. Particularly good is the trimester May, June and July, when catches may range as high as 176,000 lb. (nearly 80 tons) for a single month. Examination of the tables shows great fluctuations in the catch during these three months; this is due largely, if not entirely, to variability in the weather conditions dependent on the onset and character of the south-west monsoon in different years. How the vālai fishery overshadows all the other fisheries is graphically depicted in Table IX.

Offshore lining.—Next in importance to the vālai fishery is lining for sea-perch, rock-cod and jew-fishes. This is carried on upon rocky banks more or less covered with Sargasso and various

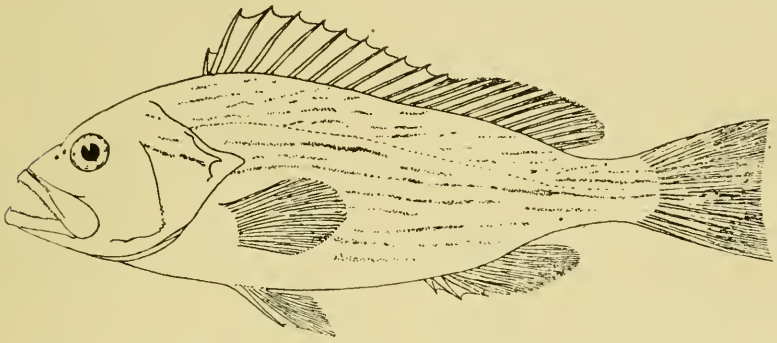

FIG. 2.—KALAWA or INDIAN ROCK-COD (Serranus undulosus). × $\frac{1}{6}$.

brown and red sea-weeds, forests of the branched tubes of *Eunice tubifex*, frequent solitary coral colonies, varied and numerous massive sponges and many showy Alcyonarians and tree-like Gorgonids. On such a rough bottom long-lining is not possible and the men have perforce to use hand lines.

Its importance in bulk of fish caught and in value, together with the fluctuations experienced from month to month, is shown in the following tabulation :—

Offshore lining at Tuticorin.

AVERAGES over four years—weight and value.

Month.	Quantity in pounds.	Value in rupees.
October	15,129	1,044
November	3,211	235
December	2,171	166
January	6,000	493
February	7,959	632
March	10,841	830
April	10,854	978
May	8,753	840
June	3,823	416
July	5,608	790
August	17,966	1,485
September	25,149	2,214
Average annual total ...	117,464	10,023

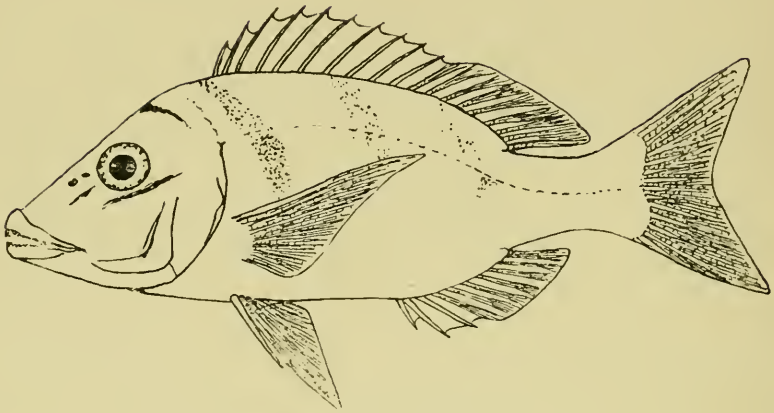

FIG. 3.—VELAMIN (Lethrinus nebulosus). × $\frac{1}{6}$.

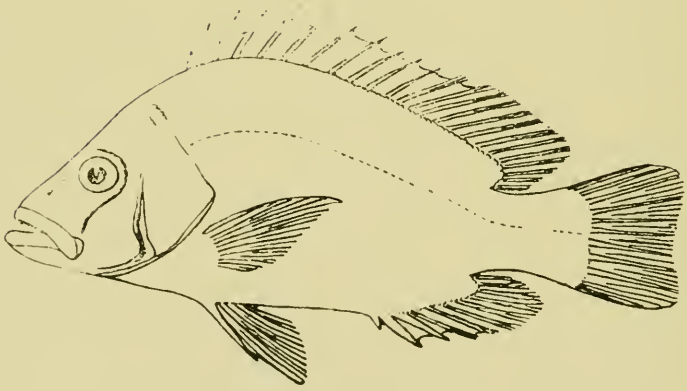

FIG. 4.—CHEPPILI (Lutjanus annularis). × $\frac{1}{6}$.

From these particulars it is seen that this fishery, like that for vālai, is an all-year-round one; the fishes concerned are not migratory under ordinary circumstances and the fishery is controlled in the main by weather conditions, being best in the light wind seasons between the monsoons. The better one lasts from the middle of August to the end of October; it begins as the strength of the south-west monsoon dies down in August and continues till strong and steady north-east winds set in towards the end of October. A second good fishing season occurs during the calm weather period of March, April and May, but this favourable weather is largely offset by the perfect clearness of the water—always a serious drawback in bottom fishing.

The fishes caught consist in the main of Kalawa *(Serranus undulosus)*, Cheppili *(Lutjanus annularis)*, Chēri *(Sciaena miles)*, Moonjan *(Serranus hexagonatus)*, Thambuvan *(Serranus polleni)*, Tholan *(Diagramma punctatum)*, Velamin *(Lethrinus nebulosus)*, Panna *(Otolithus ruber)*, Karumuthal *(Chrysophrys berda)*, with occasional rays and dogfishes. Generally the majority of the round fish caught by offshore lining may be grouped as rockfishes from their habit of frequenting rocky ground; the three families of Serranidae, Sciaenidae and Sparidae contribute the bulk of these fishes.

The bait used consists chiefly of small fishes, the most valued being the Kola or Anchovy *(Engraulis dussumieri)*, Thondai *(Dussumieria acuta)*, Chalai *(Clupea atricauda* and *Clupea sindensis)*, Sudai *(Clupea fimbriata)*, and pieces of Vālai *(Chirocentrus dorab)*.

The following table shows the contributions made respectively by the nine most abundant rockfishes to the spoils of this method of fishing:—

AVERAGE monthly catches of nine species of Rockfishes throughout the year, based on four years' statistics, 1911—15.

Name.			October	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Total for year.
Kalawa (Serranus undulosus).	Weight ...	Lb.	5,469	1,968	1,000	2,749	3,627	2,927	2,846	1,845	385	1,150	4,444	7,745	36,155
	Value ...	Rs.	598	215	110	301	397	320	312	201	42	125	486	847	3,954
Chēri (Sciaena miles and spp.).	Weight ...	Lb.	71	49	67	54	53	82	29	19	20	54	40	24	562
	Value ...	Rs.	7	4	6	5	5	8	3	2	2	5	4	2	53
Cheppili (Lutjanus annularis).	Weight ...	Lb.	1,135	326	103	509	680	1,499	980	313	288	775	2,151	3,353	12,112
	Value ...	Rs.	90	26	8	39	53	117	76	24	23	61	168	262	947
Moonjan (Serranus hexagonatus).	Weight ...	Lb.	132	109	149	309	145	239	81	34	6	63	266	560	2,093
	Value ...	Rs.	10	9	12	24	11	19	6	3	...	5	21	43	163
Thambuvan (Serranus polleni).	Weight ...	Lb.	815	338	569	1,430	1,866	2,236	1,306	618	56	119	415	1,378	11,146
	Value ...	Rs.	64	27	44	112	145	175	102	49	4	9	32	108	871
Tholan (Diagramma punctatum).	Weight ...	Lb.	8	21	19	45	123	32	129	1,125	588	87	29	29	2,235
	Value ..	Rs.	1	2	2	4	11	3	12	105	55	8	3	3	209
Velamin (Lethrinus nebulosus)	Weight ...	Lb.	1,583	465	192	570	793	1,782	1,718	1,514	1,247	2,177	3,453	3,541	19,035
	Value ...	Rs.	146	44	18	54	74	168	161	142	117	204	324	332	1,784
Panna (Otolithus ruber)...	Weight ...	Lb.	648	874	970	589	513	394	210	127	96	106	72	149	4,748
	Value ...	Rs.	40	55	61	37	32	25	13	8	6	7	4	9	297
Karumuthal (Chrysophrys berda).	Weight ...	Lb.	24	36	22	17	44	12	16	7	11	28	6	7	230
	Value ...	Rs.	2	3	2	2	4	1	1	1	1	2	1	1	21

During the two special seasons for offshore lining the number of boats employed rises to 18; when the weather is adverse, as during the height of the south-west and north-east monsoons, a number of the lining fishermen resort to other methods of fishing or take up lighterage work, but there are seldom less than five canoes employed even in the height of the monsoon. It has to be remembered that in July for example, when the south-west monsoon

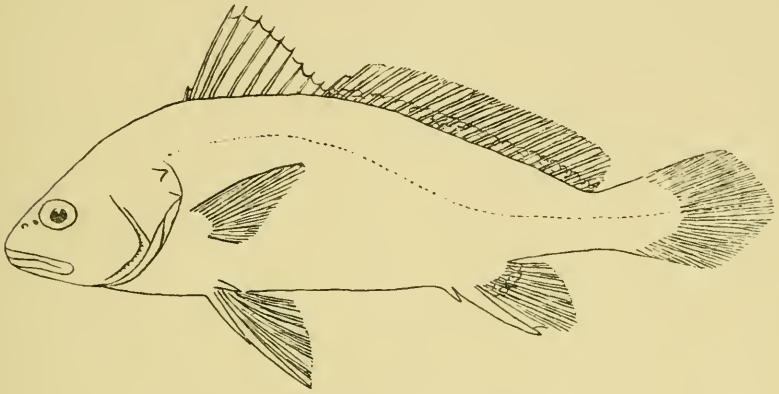

FIG. 5.—CHĒRI (Sciaena miles). × ¼.

is at its height, wind and sea are not continuously violent as text-books would have us believe. There are many interludes of comparatively quiet weather and of these the line fishermen take ample opportunity. Their craft are excellent sea-boats not to be compared for a moment with the dug-out canoes and crank slab-sided punt-like fishing boats of the Malabar coast. They are really boats and not canoes; their crews are expert sailors in the true sense of the word and despise the slaves of the oar. Their boats are of the same type as those of the vālai drift-netters but of slightly smaller size. They run to about 28 feet overall, with a beam of 4 feet and depth of 3 to 3½ feet. Each crew consists of from five to eight men according to the size of the boat.

Inshore Lining.—A second important group of line fishermen concern themselves with inshore fishing for a smaller class of fish than those that frequent the rocky pearl bank areas. These men number about 40 and work 13 small boats manned each by two to three men. The boats are the smallest of those engaged in the Tuticorin fisheries, but except in size are similar to the larger ones already described. They range between 14 and 16 feet in length, with an extreme breadth at the gunwale of 3 to 3¼ feet, depth 2

to 2¼ feet. They carry one small mast furnished with the usual squarish lug-sail.

This inshore lining is prosecuted with greatest success from November to March inclusive, i.e., during the period of the north-east monsoon when the water of Tuticorin bay is always more or less turbid. Another and probably more potent factor making for good catches during the north-east monsoon period is that this season and particularly the months from November to February inclusive, coincides with the rains; the great bulk of flood water from the Tambraparni River and the local streams is then emptied into the sea. This land drainage causes a notable increase of organic matter in the inshore water, which, too, is banked up into the Tinnevelly bays and coast indentations by the off-sea winds then prevailing. As a direct consequence the neritic or inshore plankton increases enormously; firstly, filamentous algæ, diatoms, peridinians, and other protista, and then, feeding upon them, a whole host of the smaller crustaceans—copepods, schizopods and prawns. These small fry are the normal food of the small fishes caught by the inshore liners, and the increase and local concentration of these are the direct consequences of this superabundance of foodstuff in shallow water. From the following table it will be seen however that a fairly good second fishing season occurs in June and July. The cause for this is more than a little obscure, but I am inclined to think it is due in part to freshets that then come down the Tambraparni from the Travancore hills and provide a second though smaller supply of organic matter for the sustenance and increase of the neritic plankton and the consequent attraction of small fish.

QUANTITY and value of small fishes caught month by month by inshore lining based on statistics for the four years 1911—15.

Month.	Weight in pounds.	Value in rupees.
October	1,953	127
November	14,760	955
December	15,463	1,046
January	25,772	1.766
February	15.876	970
March	10,515	695
April	984	77
May	339	24

Month.	Weight in pounds.	Value in rupees.
June	4,335	276
July	3,344	284
August	340	26
September	...	...
Total ...	93,681	6,236

The chief species caught are Kathalai *(Sciaena maculata)*, Kurumin *(Pristipoma maculatum)*, Kelakkan *(Sillago sihama)*, Nagarai *(Upeneoides* spp.*)*, Kili *(Therapon puta)*, Kuthippu *(Lactarius delicatulus)* and Karal *(Equula* spp. and *Gazza* spp.*)*.

The following table gives the quantities in pounds of the seven principal fish caught by this method of fishing throughout the year:—

Name.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Total for the year.
													LB.
Kathalai ..	1,901	7,448	9,471	18,200	10,668	5,507	756	18	2,030	1,608	216	..	57,823
Kurumin ..	447	496	713	553	335	210	94	2	75	119	29	..	3,073
Kelakkan ..	767	1,993	1,442	1,933	1,060	862	113	16	412	314	93	..	9,005
Nagarai	1,456	516	304	154	392	1,219	644	12	11	27	1,502	..	6,237
Kili	1,340	4,287	2,653	3,896	2,448	1,837	245	113	1,577	886	97	..	19,379
Kuthippu ..	2,326	625	97	196	136	397	182	167	202	216	161	..	4,705
Karal	2,106	1,443	902	462	594	2,042	812	468	21	69	380	..	9,299

The bait used in this handline fishing consists almost exclusively of Penæid prawns belonging to the three species *Penaeus indicus*, *Penaeus carinatus* and *Penaeus affinis*. The catching of this bait is the special occupation of about 20 men who obtain it by a small hand seine called *Vangu valai*, worked by two men. Formerly the line fishermen often experienced much delay in obtaining their supply of bait as they had to wait idle ashore each morning till a sufficient supply had been caught by the Vangu valai men. This delay is now largely avoided by the introduction by this department of prawn store baskets, wherein prawns caught overnight can be kept alive till required by the line fishermen.

Trolling.—Until 1912 this fishery was in the hands of Sinhalese fishermen who came across annually from Ceylon with their outrigger canoes or kūllas, at the beginning of the north-east monsoon and who returned home in March. The year named was characterized by an exceptionally severe outbreak of cholera in Tuticorin; this, combined with the restrictive quarantine measures adopted by the Ceylon authorities against passengers coming from Tuticorin,

had such a deterrent effect that no Sinhalese fishermen came that season and, once broken, the custom has not been resumed.

As trolling provides the bulk of the fish (seer) most esteemed by Europeans and as the market price in consequence is better than for any other fish, there was distinct inducement to the local fishermen to supply the want caused by the defection of the Sinhalese men. For the first year little progress was made, and the catch for the year October 1912 to September 1913 fell by 50 per cent compared with the preceding year's catch (11,835 lb. as against 24,438 lb.). But a year's experience revealed to the local men, that, contrary to their own belief, no special virtue is inherent to the Sinhalese outrigger as against their own boats; the latter sail quite fast enough with a good wind to make trolling for seer a success. The success of the pioneer boats was so obvious that the number engaged in this branch of fishing rapidly increased and if Sinhalese fishermen ever come again to Tuticorin, they will find themselves supplanted, and with strong competition to face.

The following table shows the quantity and value of fish obtained by this method during a four years' period, viz.:—

Year.	Quantity. LB.	Value. RS.
October 1911 to September 1912 ...	24,438	2,294
October 1912 to September 1913 ...	11,835	1,220
October 1913 to September 1914 ...	33,673	3,519
October 1914 to September 1915 ...	24,866	3,291
Average annual total. ...	23,703	2,581

To show how the catches are distributed throughout the different months, the following tabulation has been prepared:—

AVERAGE monthly weight of fish obtained by Trolling based upon the four years' statistics, 1911–1915.

Month.	Weight. LB.	Month.	Weight. LB.
October	1,067	April	Nil.
November	10,367	May	177
December	6,886	June	49
January	3,647	July	34
February	961	August	Nil.
March	467	September ...	48
Total for north-east monsoon season.	23,395	Total for south-west monsoon season.	308

The reason for the vastly better catches during the north-east monsoon is that then the sea is clear and the wind just strong enough to give the boats sufficient speed through the water and yet carry full sail. In the south-west monsoon poor fishing results partly from the frequent turbidity of the water and partly (more) from the fact that wind and sea are then usually too high to permit the local boats to carry full sail ; it is at these times that the outrigger canoes of Ceylon and Palk Bay come to the front by reason of their greater power to stand up to heavy weather.

Madi Valai.—This fishery ranks fourth at Tuticorin in order of importance, both in value and in weight of fish landed on the beach. It is carried on entirely by catamaran fishermen belonging to neighbouring fishing villages, chiefly Pinnacoil, Sippikulam and Vaipar. These men, when weather conditions are favourable, resort to Tuticorin as being a much better market for fresh fish than

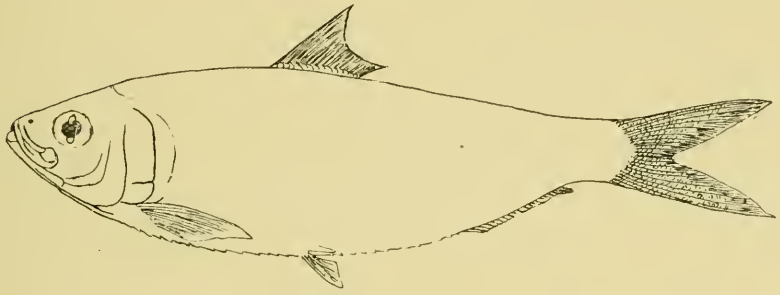

FIG. 6.—SUDAI (Clupea fimbriata). × $\frac{2}{3}$.

their own villages. In the height of the season, October to March, as many as 20 catamarans make Tuticorin their fishing headquarters. These catamarans are of special type, and differ entirely from those used on the Coromandel coast. Instead of being constructed in raft shape of five comparatively slender logs as the latter usually are, these Tinnevelly catamarans consist of three massive logs, kept permanently tied together ; the centre one is fitted at a lower level than the two side ones, and in this way a distinct trough-shaped hollow is formed, imparting to the catamaran the suggestion of a primitive boat. Each is manned usually by two men. Catamarans are worked in pairs in madi valai fishing, the net employed being a primitive trawl worked much as an otter trawl is, with the substitution of catamarans in place of otter boards. Each end of the net is aboard one catamaran ; in working it, the two catamarans sail on a parallel course at an appropriate

distance apart, closing in as the men haul the net. The contents are miscellaneous round fish; among the chief species taken are Chalai *(Clupea atricauda* and *Clupea sindensis)*, Sudai *(Clupea fimbriata)*, Thondai *(Dussumieria acuta)*, Venganai *(Pellona indica)*, Karal *(Equula* spp. and *Gazza* spp.), and Nagarai *(Upeneoides* spp.).

The best catches are made during the north-east monsoon and the intermonsoon periods of variable weather; in the height of the south-west monsoon the weather is too rough to permit of regular and effective work.

The weight and value of the catches made during the four years 1911—1915 were as follows:—

Year.	Weight in pounds.		Value in rupees.	
	Brought ashore by fishing boats.	Bought at sea by middlemen	Brought in by fishing boats.	Brought in by middlemen.
October 1911 to September 1912 ...	98,658	30,818	5,492	1,838
October 1912 to September 1913 ...	71,222	65,396	3,307	3,394
October 1913 to September 1914 ...	41,087	40,064	2,827	2,838
October 1914 to September 1915 ...	37,258	33,399	2,523	2,505
Average annual total ...	62,056	42,419	3,537	2,644

The average catch per month is shown in the following tabulation based upon four years' statistics (1911—15):—

Month.	Weight. LB.	Month.	Weight. LB.
October	13,450	April	9,538
November	15,388	May	1,358
December	10,091	June	118
January	14,799	July	173
February	12,185	August	4,375
March	13,202	September ...	9,798
Total for north-east monsoon season.	79,115	Total for south-west monsoon season.	25,360

Kola Valai.—The Kola net is a small-meshed drift net employed in catching sardines and anchovies, kola being the local name for one of the anchovies *(Engraulis dussumieri)*. These fishes are in great demand among the lower classes because of their tastiness and low price.

About twelve boats are employed in this fishery which is in full swing from the beginning of September till the middle of February when it begins rapidly to diminish. From April to July inclusive the fishery is unproductive, with March and August both very poor months.

During the season about twelve boats are employed. Each runs to a length of from 17 to 18 feet, and carries a fleet of 8 to 9 nets, measuring (each) 13 to 14 fathoms in length by 3½ to 4 fathoms deep. The mesh is ¾ inch from knot to knot and is made of No. 14 cotton. The nets are never barked. The crew of each boat consists of three or four men.

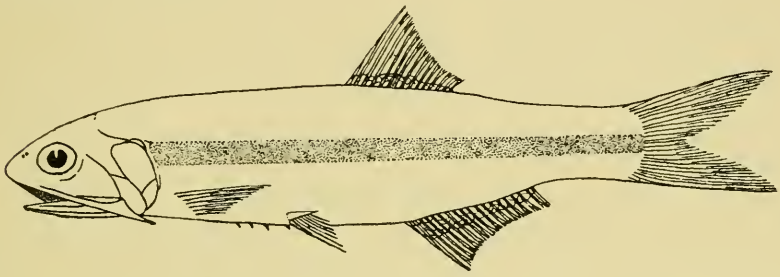

FIG. 7.—INDIAN ANCHOVY (Engraulis dussumieri). × ⅔

The catches for the four years 1911—15 amounted to the following quantities, valued as shown, viz. :—

Year.	Weight in pounds.	Value in rupees.
October 1911 to September 1912 ...	30,322	1,350
October 1912 to September 1913 ...	31,588	1,618
October 1913 to September 1914 ...	62,257	3,828
October 1914 to September 1915 ...	32,498	1,834
Average per annum ...	39,166	2,157

The distribution of the catch throughout the year averaged as follows, the figures being based on four years' statistics, 1911—15 :—

Month.	Weight. LB.	Month.	Weight. LB.
October	8,540	April	774
November	4,662	May	12
December	1,497	June	...
January	8,808	July	146
February	3,543	August	1,615
March	1,297	September ...	8,272
Total for north-east monsoon period.	28,347	Total for south-west monsoon period.	10,819

Minor fishing methods.—The foregoing methods are the only ones of importance employed at Tuticorin, the others practised being of minor economic value. The chief of these latter are the Pachu valai, the Vangu valai and the Kalla valai.

The first named is a small drift net of mesh 1½ inch from knot to knot, employed in catching Puvali *(Pellona elongata)* Kurumin *(Pristipoma maculatum)*, Karal *(Equula* spp. and *Gazza* spp.), Sudai *(Clupea fimbriata)*, Chalai *(Clupea atricauda* and *Clupea sindensis)*, and Venganai *(Pellona indica)*. The season runs from February to April. The catch in 1914 15 amounted to 4,771 lb. of a value of Rs. 374.

The Vangu valai is of greater importance as the inshore liners depend upon the produce of this net for their bait. It is a small hand seine worked by two men in lagoons and in the shallows of the harbour. Its chief catch consists of prawns (Penaeids) and fish fry. In regard to the latter it is most destructive and some restriction upon its employment will probably be necessary when the time be ripe for the introduction of regulative fishery measures.

The average annual catch of prawns and fish fry is estimated to be over 35,000 lb. having a value of Rs. 2,500. Were the catch to consist wholly of prawns the value would be considerably greater, as the line fishermen willingly give 1½ anna per pound for them as bait; fish fry sell at much less than this rate—from six to nine pies per lb. only—thereby reducing the average to about eight pies per lb.

The Kalla valai or "thief net," is a net used by four men in breast-high water. It is held upright by two men as a semicircular wall against which the fish are driven by the other two men, the two ends being brought together quickly at the same time. Mullet are caught in some quantity by this method which produced in 1914-15 a weight of 8,403 lb. of fish, valued at Rs. 739.

Fish bought at sea.—In addition to the fish caught by boats working from Tuticorin as their headquarters, a considerable quantity is bought at sea by boats which go out specially to purchase fish from fishermen working from Pinnacoil and other neighbouring villages.

During the four years 1911—15, an annual average of 42,419 lb. of fish was brought into Tuticorin by these carriers, the value being estimated at Rs. 2,644.

Wholesale rates.—Owing to the fact that no fish is sold either wholesale or retail by weight or by measure, and that all is sold singly or by the heap according to the judgment of the eye, a fair average valuation by weight has been difficult to fix, especialiy as there are marked fluctuations according to demand and variations in supply. The list given below is, I believe, a fairly accurate approximation to the mean price for each kind of fish quoted; it enables us also to judge of the relative value put upon the different species locally. The forty-one rates quoted are all per pound avoirdupois, and the qualities are tabulated according to price, beginning with the most expensive.

Average wholesale prices ruling at Tuticorin for forty-one species of fishes. Rates quoted are per pound avoirdupois :—

English name.	Tamil.	Rate in annas.
Seer	Seela	$2\frac{1}{2}$—3
Pomfret	Vaval	$2\frac{1}{2}$—3
Hilsa	Ullam	2—$2\frac{1}{2}$
(Chorinemus)	Katta	$1\frac{3}{4}$—2
Barracuda	Ulli	$1\frac{1}{2}$—2
Bonito	Surai	$1\frac{1}{2}$—2
Tunny	Keluvalai	$1\frac{1}{2}$—2
Butter-fish	Kadavula	$1\frac{3}{4}$—2
Bamin	Kalai	$1\frac{1}{2}$—2
Horse-mackerel	Parai	$1\frac{1}{2}$—2
(Lactarius)	Kuthippu	$1\frac{1}{2}$—2
Indian Whiting	Kelakkan	$1\frac{1}{2}$—$1\frac{3}{4}$
Soles	Adal	$\frac{3}{4}$—$1\frac{3}{4}$
Rock Cod	Kalawa	$1\frac{1}{2}$—$1\frac{3}{4}$
Sea Perches	Bhandari, Thambuvan, Moonjan, Cheppili, Kili.	$1\frac{1}{2}$
(Diagramma)	Tholan, Mathanam	$1\frac{1}{2}$
Sea Breams	Velamin, Karumuthal, Theenan.	$1\frac{1}{2}$—$1\frac{3}{4}$
(Lobotes)	Sadayan	1—$1\frac{1}{2}$
Grey Mullet	Athumin, Manalai	1—$1\frac{1}{2}$
Spotted Dory	Painthai	1—$1\frac{1}{2}$
Vālai	Vālai	$1\frac{1}{4}$—$1\frac{3}{4}$
Indian Herring	Puvali	1—$1\frac{1}{4}$
Jew-fishes	Seri, Kathalai	1—$1\frac{1}{4}$
Mackerel	Ailai	1—$1\frac{1}{4}$

English name.	Tamil.	Rate in annas.
Sardines	Chalai, Sudai, Thondai ...	¾—1
(Otolithus)	Panna	1—1 1/6
Red Mullet	Nagarai, Lomian	¾—1
Grunter	Kurumin	¾—1
Sharks	Sura	¾—1
Saw-fish	Vela	¾—1
Plough-fish	Uluvai, Mattiamichael ...	¾—1
Rays	Thirukkai	¾—1
Sword-fish	Thalapathu	1
Dolphin	Ailis	1
		Rate in pies.
Anchovies	Kola	6—9
White-bait	Nethili	6—9
Gar-fish	Muthal	6—9
(Gerridae)	Karal, Udagam	6—9
Cat-fish	Keluthu, Thedu	8—9
Trigger fish	Kilathi	6—8
Ribbon fish	Savalai	6

NUMBER AND DISTRIBUTION OF THE FISHERMEN, ETC.

The fishermen of Tuticorin are almost exclusively Parawas by caste, and Roman Catholics in religion. A few Muhammadans occasionally work as paid hands. The Parawa fishers total about 520 men, divided as follows into sub-sections according to the method of fishing they practise principally :—

Drift net fishermen :—	
Vala valai fishers	180
Kola and Pachu valai fishers	72
Vangu valai fishermen	20
Line fishermen :—	
Offshore liners	126
Inshore liners	40
Trollers	82
Total ...	520

No figures are given above for Madi valai men as none of these belong to Tuticorin.

The numbers given represent the average of men working when the respective fisheries are in vigorous prosecution; they fluctuate considerably however from time to time, as they use different nets at different seasons and because a certain number of the men take up other work either when fishing is poor, or when the counterattraction is great. For example when the port is busy with exports or imports and the demand for lighterage is great, a certain proportion of the fisher class find it more profitable to act as lighter crews. Or again they may quarry coral on the reefs, or enlist as chank divers. A pearl fishery in Ceylon causes a great exodus of fishermen and lightermen as nearly all are fairly expert divers. At such a time fish become scarce in the Tuticorin market and the discharge and loading of steamer cargoes a matter of much difficulty, owing to the consequent shortage of labour.

The men are by no means thrifty, but a living wage is easily made, sufficient to ensure an adequate dietary and to keep their families in comparative comfort, judging this by the ordinary standard of the labouring classes of the neighbourhood. On an average I calculate that they earn about 12 annas per head per working day. Apart from food and clothing, a considerable portion of their earnings goes in the purchase of toddy and this undoubtedly is the principal cause preventing a considerable improvement in their economic condition. Taken generally they are a fine sturdy race with a marked sense of independence; inclined to be quarrelsome and noisy but easy to control if they be treated with sympathy and firmness. They are happy in being largely 'freemen' in the financial sense. Their catches are sold by auction immediately they come to land—there is no sowcar middleman who, because of money advanced, is able to take their catch at his own rates and keep them in perpetual penury as happens so often on the Ramnad coast. They work on a fair share system whereby in the case of net fishermen, the proceeds are divided thus:—half the total to the owner of the nets for their upkeep and replacement and the other half in equal shares to each fisherman and to the boatowner who ranks in this division of proceeds on an equal basis with a fisherman. If they consider the auction rates too low, due usually to some attempt at combination to depress rates on the part of the dealers, I have several times found the fishermen decline to sell at such rates and rush the fish off to the market to sell direct to the public. The life is however a

hand-to-mouth existence, and it is the exception to find that any of them save money. Those who do are usually the men who own the boats and nets.

How far improvements are possible in the local industry it is difficult to determine. Longer fleets of nets in the case of the drift netters seem the most promising line of advance, but at present this is barred by the fact that the size of boat now in use is the largest which oar-power can manage during calms and head winds—these boats carry as many nets as the accommodation will permit. As suggested above, motor power instead of oars would give greater net accommodation and would save several men's labour and wages. Against this at present is the difficulty experienced in finding men able to work and care properly for a marine motor upon a low wage. The only remedy I see is the establishment of a marine motor school where men of the fisher class shall be taught the mechanism and working of a simple type of marine internal combustion engine. Nothing of this at present exists and fishery progress is hampered directly and most seriously by this want. Given a supply of fishermen mechanics, I am convinced there are moneyed men in the ranks of the fisher castes who would be willing to put motor fishing boats into commission. At present the average marine motor driver knows just enough to spoil his engine besides having an inordinate idea of his own value.

TUTICORIN,
7th September 1916. JAMES HORNELL.

LIST OF TABLES ANNEXED.

TABLE I.—List of the principal food fishes caught at Tuticorin arranged alphabetically under their vernacular names, together with their English and scientific synonyms, which latter are according to the nomenclature given in Day's "Fishes of British India," London, 1889.

Vernacular names.	Scientific names.	English popular names.	Family.
Adal	Cynoglossus spp.	Sole	Pleuronectidae.
Ailai	Scomber microlepidotus .	Indian Mackerel ..	Scombridae
Ailis	Coryphaena hippurus ..	Dolphin ...	Coryphaenidae.
Athumin ...	Mugil borneensis and M. speigleri.	Grey Mullet ...	Mugilidae.
Bhandari .	Serranus gilberti	Sea-perch . .	Serranidae.
Chalai ...	Clupea sindensis and C. atricauda.	Sardine	Clupeidae.
Cheppili ...	Lutjanus annularis ...	...	Serranidae.
Cheri	Sciaena miles	Jew-fish	Sciaenidae.
...	Pristipoma hasta	Grunter	Pristipomatidae.
Chevani	Psettus argenteus and Trachynotus ovatus.	...	Carangidae.
Elathi	Scatophagus argus ...	Banded Dory ...	Squamipinnes.
Iranian	Lutjanus gibbus	..	Serranidae.
Kalar	Chatoessus chacunda, Ch. nasus and Clupea kanagurta.	Sardines' ..	Clupeidae.
Kalawa	Serranus undulosus and S. semipunctatus.	Indian Rock-cod.	Serranidae.
Kalvetti .. .	Platycephalus scaber and P. insidiator.	Flat head .. .	Cottidae.
Kannadikaral ...	Mene maculata	.	Coryphaenidae.
Karal ..	Equula spp. and Gazza spp.	.	Gerridae.
Karuvalan thirukkai.	Trygon walga	Stingray ..	Trygonidae.
Karumuthal ...	Chrysophrys berda	Silver bream ...	Sparidae.
Katta	Chorinemus lysan and C. tala.	...	Carangidae.
Katti Kalai ...	Polynemus spp.	Indian Salmon, Bamin.	Polynemidae.
Kattikaral .	Equula daura	..	Gerridae.
Kelakkan ..	Sillago sihama	Indian Whiting ...	Sillaginidae.
Keluthu and Thedu.	Arius spp.	Cat-fish .	Siluridae.
Keluvalai	Thunnus thynnus .. .	Tunny	Scombridae.
Kilathi	Balistes spp. .. .	File-fish, Trigger-fish.	Sclerodermi.
Kili	Therapon puta, T. jarbua and T. quadrilineatus.	...	Serranidae.
Kilinjan	Julis lunaris, Platyglossus dussumieri and Pseudoscarus dussumieri.	Parrot fishes ...	Labridae.
Kirimin Chalai ...	Clupea leiogaster ...	Sardine	Clupeidae.
Koimin	Clupea ilisha (juv.)	Hilsa	Clupeidae.
Kola	Engraulis dussumieri, E. taty and E. setirostris.	Anchovies ...	Clupeidae.

Vernacular names.	Scientific names.	English popular names.	Family.
Koliamuthal ...	Belone strongylura and Hemirhamphus spp.	Gar-fishes ...	Scombresocidae.
Komariansura ...	Ginglymostoma concolor.	...	Scyllidae.
Kombansura ...	Zygaena blochii	Hammer-headed shark.	Carchariidae.
Kopparaikulla ...	Histiophorus brevirostris.	Swordfish .	Xiphiidae.
Koppulisura ...	Triaenodon obtusus .		Carchariidae.
Kopputhirukkai	Dicerobatis eregoodoo ...	Ox-ray ...	Myliobatidae.
Kosura	Carcharias melanopterus ..	...	Carchariidae.
Kothalai	Lethrinus miniatus ...	...	Sparidae.
Kurangansura ...	Chiloscyllium indicum .	Dogfish	Scyllidae.
Kurumin ...	Pristipoma guoraca	Grunter	Pristipomatidae.
Kurungai .. {	Clupea ilisha (juv.)	. .	Clupeidae.
	Chatoessus chacunda ...		
Kutha	Engraulis dussumieri ...	Anchovy & White-bait.	Clupeidae.
Kūral	Sciaena sp.	Jew-fish	Sciaenidae.
Kuruvalai	Lutjanus rivulatus	...	Serranidae.
Kuthippu	Lactarius delicatulus ..		Lactariidae.
Lomian ... {	Upeneoides sp.	Red Mullet .	Mullidae.
	Synagris tolu	...	Percidae.
Manalai	Mugil speigleri	Grey Mullet .	Mugilidae. .
Manja Kili ...	Pristipoma dussumieri ..	...	Pristipomatidae.
Mapillaithambuvan.	Serranus miniatus... ..	...	Serranidae.
Mathanam ...	Diagramma crassispinum and D. griseum.	...	Pristipomatidae.
Mattia-michael	Rhyncobatus ancylostomus.	...	Rhinobatidae.
Menna	Elops saurus	...	Clupeidae.
Moonjan	Serranus hexagonatus ..	Sea-perch ...	Serranidae.
Muthal	Hemirhamphus xanthopterus.	Half-beak ...	Scombresocidae.
Nagarai	Upeneoides vittatus ...	Red Mullet ...	Mullidae.
Neduvalithirukkai.	Myliobatis maculata .	...	Myliobatidae.
Netheli	Engraulis purava	Anchovy & White-bait.	Clupeidae.
Neyadal	Psettodes erumei ...	..	Pleuronectidae.
Oramin	Teuthis oramin ..	...	Teuthididae.
Orandai	Acanthurus lineatus ...	Spine-tail... ...	Acanthuridae.
Orattukappulli ...	Lethrinus miniatus ...	Sea-bream ...	Sparidae.
Oriavelamin ...	Lethrinus harak ...	Sea-bream ...	Sparidae.
Otavaikaral ..	Gazza equulaeformis	.	Gerridae.
Pai Chalai ..	Clupea longiceps ...	Oil-sardine ...	Clupeidae.
Painthe ...	Drepane punctata ...	Spotted Dory	Drepanidae.
Palamin ...	Elops saurus and Chanos salmoneus	...	Clupeidae.
Palsura . ..	Mustelus manazo .	...	Carchariidae.
Pamuttan ..	Scolopsis bimaculatus ...	...	Sparidae
Panna .. .	Otolithus ruber.	...	Sciaenidae.
Pannan Thondai ...	Dussumieria hasseltii ...	Sardine	Clupeidae.
Pannikilathi ...	Balistes stellaris ...	Trigger-fish ...	Sclerodermi.
Parai	Caranx carangus, C. hippos, C. djedaba and C. leptolepis.	Horse-mackerel ...	Carangidae.
Parullam	Myripristis murdjan and Holocentrum rubrum.	..	Berycidae.
Pattani Kili ...	Lutjanus quinquelinearis.	...	Serranidae.
Poovali	Pellona elongata & P. filigera.	Indian Herring.	Clupeidae.

Vernacular Names.	Scientific names.	English popular names.	Family.
Puchikaral	Equula insidiatrix and E. ruconius.	...	Gerridae.
Pullikalawa ...	Serranus angularis	Spotted sea-perch.	Serranidae.
Pullikathálai ...	Sciaena maculata ...	Spotted jew-fish ..	Scienidae.
Pullikurumin ...	Pristipoma maculatum	Grunter ...	Pristipomatidae.
Pullithirukkai ...	Trygon uarnak	Stingray	Trygonidae.
Rajalikurungan-sura.	Stegostoma tigrinum ..	Zebra shark ...	Scyllidae.
Sadavalanthirukkai.	Trygon sephen	..	Trygonidae.
Sadayan	Lobotes surinamensis ...		Lobotidae.
Savalai	Trichiurus savala ...	Ribbon-fish	Trichiuridae.
Seela	Cybium commersonii ...	Seer	Scombridae.
Seenathambuvan ..	Serranus miniatus ...	...	Serranidae.
Senjikilathi ...	Balistes erythrodon	...	Sclerodermi.
Sudai	Clupea fimbriata	Sardine	Clupeidae.
Sukkankiri Parai ...	Caranx gallus ...	Horse-mackerel ...	Carangidae.
Sumbakilathi ..	Triacanthus brevirostris ..	...	Sclerodermi.
Sura	Selachoidei ...	Sharks	Sub-order Selachoidei.
Surai	Thunnus pelamis ...	Bonito	Scombridae.
Thalapathu ...	Xiphias gladius ...	Sword-fish ...	Xiphiidae.
Thambuvan ...	Serranus polleni	Sea-perch ...	Serranidae.
Tharalai	Ephippus orbis	...	Squamipinnes.
Theenan	Lethrinus rostratus ...	Pig-faced bream ...	Sparidae.
Thirukkai	.....	Stingrays and Eagle rays.	Trygonidae and Myliobatidae.
Tholan	Diagramma punctatum ...	...	Pristipomatidae.
Thondai	Dussumieria acuta ...	Sardine	Clupeidae.
Thotta	Engraulis mystax, E. taty and Opisthopterus tartoor.	..	Clupeidae.
Udagam	Sphaerodon grandoculis...	...	Sparidae.
Udagam	Gerres filamentosus ...	..	Gerridae.
Ulla and Ulli ...	Sphyraena jello and S. obtusata.	Barracuda ...	Sphyraenidae.
Ullam	Clupea ilisha ...	Hilsa .	Clupeidae.
Uluvai	Gobius sp. ...	Goby . .	Gobiidae.
Do.	Rhinobatus ...	Plough-fish ...	Rhinobatidae.
Do.	Rhyncobatus djeddensis...	Do. ...	Do.
Uru	Echeneis naucrates ..	Sucker-fish ...	Scombridae.
Vālai	Chirocentrus dorab ...	Dorab	Chirocentridae.
Val-netheli ...	Coilia spp	Anchovy and Whitebait.	Clupeidae.
Valvadi thirukkai ..	Rhinoptera javanica ...	Oyster-eating ray	Myliobatidae.
Varikaral	Equula lineolata		Gerridae.
Vaval thirukkai ...	Aetiobatis narinari ..	Bat Ray	Myliobatidae.
Vaval	Stromateus spp.	Pomfret	Stromateidae.
Velamin	Lethrinus nebulosus ...	Sea-bream ...	Sparidae.
Vengadai	Caranx rottleri	Horse-mackerel ...	Carangidae.
Venganai	Pellona indica / brachysoma ...	...	Clupeidae.
Vela ..	Pristis cuspidatus ...	Saw-fish	Pristidae.
Vennetheli ...	Engraulis commersonianus and E. indicus.	Anchovies ...	Clupeidae.
Vilangu	Muraena, Muraenesox, Uroconger and Anguilla.	Muraenas and Eels.	Muraenidae.

TABLE II.—Detailed tabulation of the monthly catches of 61 kinds of fish landed at Tuticorin during the four years 1911—15.

Number.	Name.	Year.	October.	November.	December.	Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Totals.
			LB.	LB.	LB.		LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.
1	Adal ...	1911 ...	...	...		1912	..	..	...	...	..	...	.	...	4	4
	Cynoglossus spp. ...	1912 ...	2	13	..	1913	...	...		11	...	...	3	..	..	29
	Sole	1913 ...	2	...	...	1914	..	36	...	...	...	...	...	...	...	38
		1914 ...	..	51	47	1915	22	76	144	...	...	24	50	10	23	447
		Average ...	1	16	12		5	28	36	3	...	6	13	2	7	129
2	Ailai ...	1911 ...	70	170	...	1912		..	...	..		...	...	.	90	330
	Scomber microlepidotus.	1912 ...	.	...	5	1913	...	.	...	50	129	122	29	13	280	628
	Mackerel	1913 ...	...	3	83	1914	...	74	65	..	..	...	...	242	..	467
		1914 ...	...	134	85	1915	40	14	59	224	120	58	185	86	93	1,098
		Average ...	18	77	43		10	22	31	69	62	45	53	85	116	631
3	Ailis	1911 ...		116	80	1912	...	...	..		...	..	...	...	...	196
	Coryphaena hippurus.	1912 ...	...	...	24	1913	7	...	...	247	227	28	205	..	39	777
	Dolphin	1913 ...	286	68	893	1914	333	29	60	31	...	...	...	...	46	1,752
		1914 ...	...	31	70	1915	..	...	...	...	..	..	..	...	...	101
		Average	71	54	267		85	7	16	70	57	7	51	..	21	706
4	Athumin and Manalai.	1911 .	...	..	..	1912	..	...	...	...	...	..	...	...	..	...
	Mugil borneensis and M. speigleri.	1912 ...	...	...	...	1913	...	...	...	29	...	...	188	13	...	230
		1913	...	263	60	1914		...		...		...	1,253	561		2,137
	Grey Mullet ...	1914 ...	507	979	588	1915	416	240	103	856	926	1,039	1,281	751	1,089	8,775
		Average ...	127	310	162		104	60	26	221	231	260	681	331	272	2,785

5	Bhandari	1911 ...	113	25	...	1912	...	..	..	99	12	7	...	15	221	492
	Serranus gilberti ...	1912 ...	...	...		1913	..	36	...	54	86	12	..	303	232	723
	Sea-perch	1913 ...	65	.	..	1914	105	70	12	5	...	...	...	392	2,904	3,553
		1914 ...	578	15	40	1915	..			...	11	...	...	26	44	714
		Average ..	189	10	10		26	29	3	39	27	5		182	850	1,370
6	Chalai	1911 ...	942	...	..	1912	2,268	466	60	16	...	...	...	...	20	3,772
	Clupea sindensis and C. atricauda.	1912 ...	...	1,624	15	1913	...	...		5	...	...	31	580	8,590	10,845
		1913 ...	7,247	4,021	900	1914	962	882	914	376	..	.	..	757	6,195	22,254
	Sardine	1914 ...	4,652	1,007	424	1915	998	349	272	7	..	...	13	48	1,305	9,075
		Average ...	3,210	1,663	335		1,057	424	312	101	...	...	11	346	4,027	11,486
7	Cheppili	1911 ...	1,144	447	...	1912	295	28	120	..	16	117	189	1,146	2,172	5,674
	Lutjanus annularis...	1912	524	...	...	1913	329	684	1,416	1,079	667	67	345	3,416	3,103	11,630
	Sea-perch	1913 ...	667	56	...	1914	558	648	1,214	985	294	124	458	3,052	5,620	13,676
		1914 ...	2,205	802	412	1915	854	1,362	3,247	1,855	275	843	2,108	990	2,518	17,471
		Average ..	1,135	326	103		509	680	1,499	980	313	288	775	2,151	3,353	12,112
8	Cheri	1911 ...		...	...	1912	...	15	...	5	...	7	...	...	..	27
	Sciaena miles and Pristipoma hasta.	1912 ..	232	15	5	1913	3	5	...	...	...	23	30	10	17	340
		1913 ...	..	83	104	1914	11	10	174	36	..	...	22	20	..	460
	Jew-fish	1914 ..	50	97	158	1915	200	180	155	77	77	51	166	131	80	1,422
		Average ...	71	49	67		54	53	82	29	19	20	54	40	24	562
9	Kadavula	1911 ...	176	201	125	1912	10	...	43	70	169	107	20	50	...	971
	Elacate nigra ...	1912 .	12	12	103	1913	90	..	...	33	33	30	80	86	221	709
	Butter-fish	1913	123	26	...	1914	155	91	180	52	13	...	.	144	173	957
		1914 ...	31	169	146	1915	327	120	102	51	136	58	157	...	111	1,408
		Average ...	86	102	93		146	52	81	51	88	49	67	70	126	1,011

TABLE II.—Detailed tabulation of the monthly catches of 61 kinds of fish landed at Tuticorin during the four years 1911—15—*cont.*

Number.	Name.	Year.	October.	November.	December.	Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Total.
			LB.	LB.	LB.		LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.
10	Kadumuttan ...	1911 ...	61	..	...	1912	..		...	...		...			...	61
	Scolopsis vosmeri ...	1912 ...		...	...	1913	..	...	...	42	319	...	...	...	...	361
	Sea-bream	1913 ..	32	...	...	1914	45		..	...	...	...	..	..	...	77
		1914 ..	..	...	...	1915	...	353	1,323	272	55	...	...	...	...	2,003
		Average ...	23	..	...		11	88	331	79	94	...	...	...	..	626
11	Kalai	1911 ...	362	...	...	1912		188	...	...	...	13	16	1	10	590
	Polynemus sextarius	1912 ...	...	..		1913	416	2	...	...	15	24	7	50	14	528
	Indian Salmon and	1913 ...	172	58	136	1914	28	410	85	162	...	50	4	...	...	1,105
	Bamin	1914 ...	60	206	267	1915	195	143	126	97	14	56	84	23	168	1,439
		Average ...	149	66	101		159	186	52	65	7	36	28	18	48	915
12	Kalawa	1911 ...	5,042	2,452	60	1912	877	602	1,520	582	621	253	970	3,501	5,103	21,583
	Serranus undulosus.	1912 ...	1,956	120	40	1913	2,096	3,377	4,408	2,220	1,677	256	952	5,799	10,815	33,716
	Indian Rock-cod ...	1913 ...	5,369	1,921	...	1914	4,008	7,922	4,275	2,547	2,668	192	679	7,334	11,405	48,320
		1914 ...	9,511	3,377	3,900	1915	4,014	2,606	1,505	6,034	2,416	839	1,998	1,144	3,658	41,002
		Average ...	5,469	1,968	1,000		2,749	3,627	2,927	2,846	1,845	385	1,150	4,444	7,745	36,155
13	Karal	1911 ...	5,601	537	180	1912	118	1,321	6,216	2,567	1,713	...		...	1,030	19,283
	Equula spp. ..	1912 ...	1,346	3,654	1,349	1913	349	115	20	293	38	...	95	737	3,778	11,774
	Gazza spp.	1913 ...	1,033	626	1,078	1914	811	473	1,222	178	88	20	43	590	465	6,627
		1915 ..	442	956	999	1915	570	469	709	212	32	63	137	194	277	5,060
		Average ...	2,106	1,443	902		462	594	2,042	812	468	21	69	380	1,387	10,686

14	Karumuthai ..	1911	...	...	..	1912	...	..	...	...	...	...	...	...	...	...	
	Chrysophrys berda	1912	..	...	...	...	1913	...	10	...	..	...	...	18	...	...	28
	Silver bream ...	1913	...	.	14	...	1914	...	...	...	...	...	..	53	8	..	75
		1914	.	95	131	87	1915	68	165	47	66	29	43	42	17	27	817
		Average ...		24	36	22		17	44	12	16	7	11	28	6	7	230
15	Kathalai	1911	...	1,632	5,081	12,754	1912	36,304	23,658	10,142	570	...	1,548	2,738	...	1	94,428
	Sciæna maculata ...	1912	...	3,945	16,171	14,700	1913	21,960	7,375	1,580	535	15	1,465	1,495	770	10	70,021
	Jew-fish	1913	...	1,129	2,931	6,066	1914	7,665	6,650	4,751	1,208	.	4,840	1,607	44	60	36,951
		1914	...	899	5,611	4,364	1915	6,870	4,988	5,557	710	56	268	591	50	74	30,038
		Average ..		1,901	7,448	9,471		18,200	10,668	5,507	756	18	2,030	1,608	216	36	57,859
16	Katta ..	1911	...	94	944	603	1912	...	1,175	552	472	609	150	108	42	9	4,758
	Chorinemus lysan	1912	...	...	1,082	1,362	1913	1,315	184	104	1,166	3,052	1,141	1,055	72	...	10,533
	and C. tala ...	1913	...	496	2,400	2,203	1914	707	58	292	138	563	1,511	265	84	...	8,717
		1914	.	738	2,239	2,042	1915	1,397	1,067	606	162	702	198	321	62	106	9,640
		Average ...		332	1,666	1,552		855	621	389	485	1,231	750	437	65	29	8,412
17	Kelakkan	1911	...	531	636	1,195	1912	2,280	1,752	1,901	...	...	507	539		..	9,341
	Sillago sihama ..	1912	...	1,830	5,533	1,850	1913	3,226	1,165	301	24	...	545	182	320	15	14,991
	Indian whiting ...	1913	...	396	672	1,750	1914	1,369	957	839	230	..	524	445	38	50	7,279
		1914	...	312	1,131	962	1915	856	367	406	200	62	74	88	14	81	4,553
		Average ...		767	1,993	1,442		1,933	1,060	862	113	16	412	314	93	36	9,041
18	Kelavalai	1911	...	...	4,339	780	1912	20	...	...		...	...	...	...	..	5,139
	Thunnus thynnus ...	1912	...	...	28	...	1913	...	...	...	..	...		...	...	..	28
	Tunny	1913	...	..	701	493	1914	...	...	...	...	..		...		...	1,194
		1914	...	70	465	244	1915	...	...	...	...	...	...		...	...	779
		Average ...		18	1,383	379		5	...	...	...	...	.	...	...	...	1,785

TABLE II.—Detailed tabulation of the monthly catches of 61 kinds of fish landed at Tuticorin during the four years 1911—15—*cont.*

Number.	Name.	Year.	October.	November.	December.	Year.	January.	February	March.	April.	May.	June.	July.	August.	September.	Totals.
			LB.	LB.	LB.		LB.	LB	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.
19	Keluthu	1911 ...	298	285	3,106	1912	...	232	318	84	376	415	140	308	...	5,562
	Arius spp.	1912 ...	34	1,258	2,674	1913	...	1,141	286	486	739	843	1,353	84	201	9,099
	Cat-fish	1913 ...	183	421	628	1914	1,035	468	570	73	719	508	358	179	...	5,142
		1914 ...	165	522	456	1915	780	675	458	194	607	145	489	128	186	4,805
		Average ...	170	621	1,716		454	629	408	209	610	478	585	175	97	6,152
20	Kilathi	1911 ...	127	315	590	1912	...	176	2,290	34	31	16	...	25	30	3,634
	Balistes spp.	1912 ...	...	..	...	1913		...	1,380	146	168	..	...	..	6	1,700
	Trigger-fish ...	1913 ...	129	217	...	1914	151	79	163	182	100	...	..	...	13	1,034
		1914 ...	28	61	66	1915	24	646	617	524	116	9	13	28	19	2,151
		Average ...	71	148	164		44	225	1,113	222	104	6	3	13	17	2,130
21	Kili	1911 ...	569	1,128	2,729	1912	7,387	4,631	4,652	165	112	625	1,076		140	23,214
	Therapon puta ...	1912 ...	3,574	11,830	3,380	1913	4,219	1,920	500	164	174	1,967	405	281	147	28,561
	Sea-perch	1913 .	486	1,400	3,178	1914	2,529	1,717	1,346	398	60	3,583	1,932	71	8	16,708
		1914 ...	731	2,789	1,327	1915	1,448	1,526	851	252	107	132	130	38	144	9,475
		Average ...	1,340	4,287	2,653		3,896	2,448	1,837	245	113	1,577	886	97	110	19,489
22	Kola	1911 ...	...	...	...	1912	15,287	1,997	30	...	...	...	...	...		17,314
	Engraulis dussumieri	1912 ..	1,253	..	505	1913	932	.	.	...	...	...	...	129	700	3,519
	Anchovy	1913 ...	1,667	1,623	656	1914	3,923	2,447	1,150	578	..	..	...	110	1,814	13,968
		1914 ...	1,379	511	611	1915	2,949	796	18	..	...	...	2	89	330	6,685
		Average ..	1,075	533	443		5,773	1,310	299	145	..	...	...	82	711	10,371

23	Kooral	1911	...	...	...	1912	300	200	389	...	...	...	...	...	...	889
	Sciaena sp.	1912	8	60	...	1913	...	260	40	146	137	...	...	60	...	711
	Jew-fish	1913	...	21	291	1914	12	90	64	...	...	...	20	45	..	543
		1914	55	225	91	1915	...	...	...	...	...	...	...	...	...	371
		Average ...	16	76	96		78	138	123	36	24		5	26	...	628
24	Kurumin	1911	302	...	...	1912	30	151	...	...	...	...	...	...	...	483
	Pristipoma maculatum	1912	...	...	...	1913	380	40	...	150	...	60	100	6	1,380	2,116
	Grunter	1913	1,199	651	2,049	1914	1,136	915	499	109	...	190	239	55	360	7,402
		1914	287	1,333	803	1915	667	234	342	118	7	49	135	56	71	4,102
		Average ...	447	496	713		553	335	210	94	2	75	119	29	453	3,526
25	Kuruvalai	1911	723	195	...	1912	...	12	60	319	787	809	698	590	2,304	6,497
	Lutjanus rivulatus ..	1912	752	16	...	1913	102	144	885	1,291	1,052	525	653	2,107	2,123	9,650
	Sea-perch.	1913	904	289	...	1914	349	636	848	501	364	174	203	2,581	2,552	9,401
		1914	1,737	129	89	1915	8	125	325	619	472	1,096	1,577	958	749	7,884
		Average ...	1,029	157	22		115	229	530	682	669	651	783	1,559	1,932	8,358
26	Kuthippu	1911	3,745	...	70	1912	480	129	400	36	...	7	...	...	4,177	9,044
	Lactarius delicatulus	1912	4,496	1,715	75	1913	100	158	970	594	523	550	617	154	1,042	10,994
		1913	947	354	115	1914	23	138	160	..	4	150	3	323	80	2,297
		1914	115	430	128	1915	181	118	59	97	142	102	242	167	186	1,967
		Average ...	2,326	625	97		196	136	397	182	167	202	216	161	1,371	6,076
27	Lomian	1911	90	...	...	1912	...	...	...	...	...	...	..	...	1,410	1,500
	Upeneoides sp. ...	1912	...	...	...	1913	...	...	...	...	...	...	..	.	14,981	14,981
	Red Mullet... ...	1913	...	...	...	1914	...	.	490	...	...	...	...	5,873	791	7,154
		1914	...	...	...	1915	...	...	...	...	.	..	...	..	...	...
		Average ...	23	...	...		...	...	123	...	...	...	...	1,468	4,295	5,909

TABLE II.—Detailed tabulation of the monthly catches of 61 kinds of fish landed at Tuticorin during the four years 1911—15—*cont.*

Number.	Name.	Year.	October.	November.	December.	Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Totals.
			LB.	LB.	LB.		LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.
28	Mattia-mickael .. Rhynchobatus ancylostomus ...	1911 ...	...	...	...	1912	...	...	...	...	...	...	...	..	...	...
		1912 ...	...	...	...	1913	...	...	...	...	278	...	315	70	70	733
		1913 ...	174	...	...	1914	...	...	...	...	..	...	..	...	...	302
		1914 ...	...	...	...	1915	..	128	...	...	153	128	110	116	...	507
		Average ...	44	...	...		...	32	...	...	108	32	106	47	17	386
29	Moonjan ... Serranus hexagonatus ... ... Sea-perch	1911 ...	50	74	80	1912	60	...	...	...	10	10	...	15	114	413
		1912	40	...	...	1913	211	180	88	56	44	...	...	226	1,217	2,062
		1913 ...	209	104	...	1914	134	218	683	77	4	...	...	594	732	2,755
		1914 ...	230	256	515	1915	831	184	186	190	78	16	250	228	179	3,143
		Average ...	132	109	149		309	145	239	81	34	6	63	266	560	2,093
30	Muthal ... ... Belone strongylura and Hemirhamphus spp. ... ... Gar-fish	1911 ...	...	...	...	1912	...		..	...	...	...	...	...	...	...
		1912 ...	...	...	...	1913	...	...	...	...	...	...	...	...	...	...
		1913 ...	...	...	...	1914	...	...	...	...	...	...	6	...	...	6
		1914 ...	...	...	...	1915	...	11	242	...	48	89	70	22	30	512
		Average ...	...	...	...		...	3	61	...	12	22	19	5	7	129
31	Nagarai ... ... Upeneoides spp. ... Red Mullet... ...	1911 ...	2,532	260	100	1912	52	1,104	3,651	345	...	...	25	..	1,288	9,357
		1912 ...	358	509	447	1913	160	15	185	690	22	...	...	3,291	8,430	14,107
		1913 ...	2,638	677	281	1914	78	182	912	1,382	...	8	23	2,590	1,042	9,813
		1914 ...	297	616	389	1915	325	270	128	157	25	37	60	127	227	2,658
		Average ...	1,456	516	304		154	392	1,219	644	12	11	27	1,502	2,747	8,984

32	Netheli	1911	...	...	235	...	1912	...	...	...	3	...	...	...	...	...	238
	Engraulis purava ...	1912	...	...	...	139	1913	30	...	...	...	10	...	5	122	86	392
	Whitebait	1913	...	197	173	162	1914	...	.	...	.	...	..	1,392	913	148	2,985
		1914	..	206	279	466	1915	454	397	263	94	39	70	38	23	1,040	3,369
		Average	...	101	172	192		121	99	66	24	12	17	359	264	319	1,746
33	Painthe	1911	...	...	...	...	1912	..	...	...	...	46	24	...	...	...	70
	Drepane punctata ...	1912	.	...	...	...	1913	...	...	...	1,129	180	...	...	..	...	1,309
	Spotted Dory ...	1913	...	...	...	...	1914	...	...	...	...	264	. .	...	...	...	264
		1914	...	...	30	7	1915	5	...	68	...	2,122	30	...	...	2	2,264
		Average	...	...	8	2		1	..	17	282	653	14	...	...	...	977
34	Pamuttan	1911	...	220	529	630	1912	..	60	1,880	1,039	777	...	...	...	60	5,195
	Scolopsis bimaculatus	1912	..	204	178	...	1913	...	...	1,000	230	404	...	...	...	16	2,032
		1913	..	638	1,155	...	1914	377	...	...	520	711	330	6	16	61	3,814
	Sea-bream	1914	...	658	241	...	1915	76	353	1,279	963	106		...	...	...	3,676
		Average	...	430	526	158		113	103	1,040	688	500	82	1	4	34	3,679
35	Panna	1911	..	269	411	142	1912	148	40	193	10	44	8	..	..	285	1,550
	Otolithus ruber ...	1912	...	710	680	423	1913	187	260	335	628	255	225	117	87	144	4,051
		1913	...	1,053	857	2,405	1914	959	919	341	32	31	...	196	116	30	6,939
		1914	...	561	1,549	909	1915	1,063	833	707	170	180	153	109	84	135	6,453
		Average	...	648	874	970		589	513	394	210	127	96	106	72	149	4,748
36	Parai	1911	..	639	751	...	1912	...	364	332	272	272	67	11	4	310	3,022
	Caranx spp. ...	1912	..	104	571	1,161	1913	1,118	642	174	1,275	1,000	554	899	459	698	8,655
	Horse-mackerel ...	1913	...	2,323	1,776	2,214	1914	2,126	921	1,003	65	248	449	211	439	313	12,088
		1914	..	531	1,942	1,637	1915	1,111	900	805	425	814	253	384	219	557	9,578
		Average	...	899	1,260	1,253		1,089	707	579	509	584	331	376	280	469	8,336

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Number.	Name.	Year.	October.	November.	December.	Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Totals.
			LB.	LB.	LB.		LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.
37	Poovali	1911 ...	54	24	7	1912	102	1,223	342	57	247	1	...	...	1	2,058
	Pellona elongata and	1912 ...	2	...	245	1913	509	284	159	2,225	367	564	271	28	28	4,682
	P. filigera ...	1913 ...	48	55	126	1914	534	275	860	318	131	...	24	7	46	2,424
	Indian Herring ...	1914 ..	147	63	186	1915	813	304	258	218	335	78	58	21	38	2,519
		Average ..	63	35	141		490	522	405	704	270	161	88	14	28	2,921
38	Sadayan	1911 ...	...	...	18	1912	...	..	..	...	...	10	4	15	8	55
	Lobotes surinamen-	1912 ..	30	10	17	1913	4	50	...	...	6	22	13	6	...	158
	sis	1913 ..	...	12	9	1914	...	...	...	...	...	...	...	...	...	21
		1914 ..	...	41	...	1915	480	352	208	45	...	2	...	19	12	1,159
		Average ...	7	16	11		121	101	52	11	1	9	4	10	5	348
39	Savalai	1911 ..	150	32	.	1912	...	..	..	.	...	..	...	...	5,192	5,374
	Trichiurus savala ..	1912 ..	1,831	5,700	...	1913	..	5	...	...	...	..	...	5	...	7,541
	Ribbon-fish ...	1913 ..	133	32	246	1914	29	...	...	...	..	...	..	...	...	440
		1914 ..	56	39	41	1915	258	4	34	...	...	9	9	11	12	473
		Average ..	542	1,451	72		72	2	9	...	...	2	2	4	1,301	3,457
40	Seela	1911 ..	2,392	9,511	2,964	1912	3,000	1,566	427	541	773	576	609	1,582	789	24,739
	Cybium commers-	1912 ...	72	1,963	1,408	1913	2,809	2,352	2,856	2,449	2,191	1,997	1,559	196	669	20,521
	onii	1913 ...	821	4,365	5,775	1914	3,735	1,371	1,832	1,967	1,449	6,176	1,325	483	99	29,398
	Seer	1914 ..	824	3,797	2,146	1915	2,657	1,526	1,946	385	1,484	786	4,577	1,208	205	21,541
		Average ...	1,027	4,909	3,073		3,053	1,704	1,765	1,336	1,474	2,384	2,018	867	440	24,050

41	Sudai	1911	...	2,328	...	...	1912	572	536	10	1,183	50	...	90	255	71	5,095
	Clupea fimbriata ...	1912	...	2,370	3,668	662	1913	1,033	...	...	..	...	...	466	2,735	3,518	14,392
	Sardine	1913	..	4,940	5,848	727	1914	851	917	577	243	...	...	63	1,809	6,220	22,195
		1914	...	3,544	934	478	1915	469	406	508	186	...	...	11	221	4,174	10,931
		Average	..	3,296	2,612	467		731	465	274	403	12	...	142	1,255	3,496	13,153
42	Sura	1911	..	713	200	26	1912	856	261	448	575	530	886	797	8,543	392	14,227
	Selachoidei ...	1912	.	209	709	246	1913	1,137	1,043	458	2,828	2,081	1,295	1,998	409	1,566	13,979
	Sharks	1913	.	7,785	467	575	1914	1,879	2,633	3,034	732	1,191	1,361	1,430	1,276	526	22,889
		1914	..	1,089	1,505	1,889	1915	1,964	967	538	717	1,810	1,060	2,022	5,021	1,172	19,754
		Average	...	2,449	720	684		1,459	1,226	1,119	1,213	1,403	1,151	1,562	3,812	914	17,712
43	Surai	1911	...	174	3,404	1,571	1912	233	...	...	8	...	.	...	.	...	5,390
	Thunnus pelamys ...	1912	...	...	268	938	1913	1,036	43	...	...	...	...	...	...	...	2,285
	Bonito	1913	.	277	4,819	2,921	1914	941	19	43	...	...	...	...	...	...	9,020
		1914	.	395	1,412	944	1915	763	186	46	...	...	6	15	...	..	3,767
		Average	...	212	2,476	1,593		743	62	22	2	...	1	4	...	...	5,115
44	Thalapathu ...	1911	...	...	...	...	1912	...	...	...	...	...	...	...	...	...	...
	Xiphias gladius ...	1912	..	...	...	...	1913	...	..	...	...	...	...	...	...	...	...
	Sword-fish	1913	..	...	310	265	1914	407	...	69	...	...	...	...	...		1,051
		1914	..	...	249	49	1915	415	110	...	...	58	...	...	188	...	1,069
		Average	...	...	140	78		206	28	17	...	14	...	...	47	...	530
45	Thambuvan ...	1911	..	903	184	...	1912	640	649	1,421	40	66	...	...	132	1,914	5,949
	Serranus polleni ...	1912	..	506	..	32	1913	1,026	2,081	4,270	1,661	1,015	129	60	371	1,907	13,058
	Sea-perch	1913	...	516	335	...	1914	2,356	3,290	2,127	2,288	1,152	80	50	873	1,039	14,106
		1914	..	1,336	833	2,245	1915	1,696	1,444	1,126	1,235	241	18	365	282	650	11,471
		Average	...	815	338	569		1,430	1,866	2,236	1,306	618	56	119	415	1,378	11,146

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Number.	Name.	Year.	October.	November.	December.	Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Totals.
			LB.	LB.	LB.		LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.
46	Theenan	1911 ..	109	...	...	1912	...	...	...	...	...	...	...	...	36	145
	Lethrinus rostratus	1912 ...	...	...	...	1913	...	...	...	...	...	..	...	...	...	...
	Pigfaced bream ...	1913 ...	...	...	...	1914	...	...	...	..	...	...	..	..	...	...
		1914 ..	...	80	...	1915	..	...	...	...	...	...	...	...	...	80
		Average ...	27	20	...		...	...	...		...	...	...	...	9	56
47	Thirukkai	1911 ..	452	103	...	1912	35	...	...	1,788	437	352	22	135	120	3,444
	Trygonidæ and Myliobatidæ ...	1912 ...	79	57	89	1913	247	183	...	1,343	1,274	445	333	154	274	4,478
		1913 ...	872	281	205	1914	113	349	559	..	282	420	106	300	352	3,839
	Stingrays and Eagle-rays	1914 ...	598	704	239	1915	270	438	241	396	1,235	616	655	406	652	6,450
		Average ..	500	286	135		166	243	200	882	807	458	279	249	349	4,552
48	Tholan	1911 ..	8	...	...	1912		..	108	73	651	174	...	...	...	1,014
	Diagramma punctatum	1912 ...	...	...	...	1913	...	..	...	179	606	275	84	...	20	1,164
		1913 ...	25	...		1914	52	108	..	...	2,813	728	22	34	28	3,810
		1914 ...	...	85	78	1915	127	382	18	264	431	1,173	245	84	67	2,954
		Average ...	8	21	19		45	123	32	129	1,125	588	87	29	29	2,235
49	Thondai	1911 ...	9,314	10,504	3,108	1912	11,820	2,301	8,416	7,936	...	...	...	...	162	53,561
	Dussumieria acuta ...	1912 ...	..	4,706	3,900	1913	3,265	16,297	12,035	9,258	650	...	40	4,323	1,231	55,705
	Sardine	1913 ...	2,903	1,908	4,973	1914	2,114	1,111	6,650	5,014	54	...	...	2,494	620	27,841
		1914 ...	859	6,857	2,793	1915	2,230	259	467	2,078	125	10	16	607	888	17,189
		Average ...	3,269	5,994	3,694		4,857	4,992	6,892	6,072	207	2	14	1,856	725	38,574

50	Udagam ... ... Sphaerodon grandoculis and Gerres filamentosus ...	1911	...	3	...	...	1912	...	...	...	...	...	...	...	...	...	3
		1912	...	...	...	...	1913	...	..	...	...	...	...	...	...	...	...
		1913	...	...	...	...	1914	...	...	...	...	...	...	...	...	...	...
		1914	...	...	64	44	1915	67	58	53	8	13	71	170	57	118	723
		Average	...	1	16	11		17	14	13	2	3	18	43	14	30	182
51	Ullam ... ... Clupea ilisha ... Hilsa	1911	...	...	...	...	1912	...	102	...	136	243	140	161	231	4	1,017
		1912	...	...	...	71	1913	10	25	...	217	1,679	1,084	971	44	42	4,143
		1913	..	17	58	30	1914	333	193	252	64	7	2,106	128	111	31	3,330
		1914	..	...	37	18	1915	169	78	35	32	380	209	484	...	89	1,531
		Average	...	4	24	30		128	99	72	112	577	885	436	97	41	2,505
52	Ulli ... ... Sphyraena obtusata. Barracuda	1911	...	58	745	...	1912	...	179	653	...	179	6	20	36	536	2,412
		1912	..	390	...	23	1913	123	...	180	450	189	306	646	57	95	2,459
		1913	..	565	563	254	1914	357	194	577	55	...	300	385	59	61	3,370
		1914	...	103	645	1,070	1915	859	566	203	144	389	172	557	43	98	4,849
		Average	...	279	488	337		335	235	403	162	189	196	402	49	197	3,272
53	Uluvai ... ... Rhyncobatus djeddensis and Rhinobatus spp. ... Plough-fish ...	1911	..	...	15	10	1912	...	...	...	...	..	22	155	12	58	272
		1912		49	196	20	1913	24	...	...	62	28	48	31	75	35	568
		1913	...	185	27	...	1914	...	...	64	30	...	..	14	17	2	339
		1914	...	70	117	62	1915	108	51	22	26	51	227	82	27	60	903
		Average	...	76	89	23		33	13	21	29	20	74	70	33	39	520
54	Vāḷai ... ... Chirocentrus dorab. Dorab	1911	...	5,667	7,909	4,680	1912	25,215	17,366	4,490	8,240	1,29,598	29,462	18,784	12,522	4,770	268,703
		1912	...	155	3,076	12,401	1913	21,042	13,851	13,200	36,463	35,418	26,214	19,066	2,133	2,064	185,083
		1913	...	1,991	1,433	2,812	1914	17,716	6,538	8,145	11,451	22,435	176,169	20,214	5,652	513	275,069
		1914	...	594	2,616	3,507	1915	18,162	18,145	4,743	1,551	20,568	12,123	33,857	7,413	1,964	125,243
		Average	...	2,102	3,759	5,850		20,533	13,975	7,645	14,426	52,005	60,992	22,980	6,930	2,328	213,525

TABLE II.—Detailed tabulation of the monthly catches of 61 kinds of fish landed at Tuticorin during the four years 1911—15—*cont.*

Number.	Name.	Year.	October.	November.	December.	Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Totals.
			LB.	LB.	LB.		LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.
55	Val-netheli ...	1911 ...	...	...	...	1912	...	..	...	...	...	...	...	...	...	...
	Coilia spp. ...	1912 ...	...	...	...	1913	...	...	...	...	...	...	...	...	...	...
	Whitebait	1913 ...	95	148	...	1914	...	...	...	...	...	...	...	5	...	248
		1914 ...	615	1,174	1,278	1915	1,808	2,421	1,340	44	21	8	10	77	432	9,228
		Average ...	178	330	320		452	605	335	11	5	2	2	21	108	2,369
56	Vaval	1911 ...	608	1,864	114	1912	252	534	27	321	39	66	41	...	16	3,882
	Stromateus spp. ..	1912 ...	158	163	99	1913	147	139	129	361	115	237	432	18	85	2,083
	Pomfret	1913 ...	28	...	41	1914	212	258	377	114	192	253	117	1	33	1,626
		1914 ...	9	430	414	1915	419	257	172	86	102	62	466	31	58	2,506
		Average ...	201	614	167		258	297	176	220	112	155	264	12	48	2,524
57	Vela	1911 ...	...	...	...	1912	...	...	...	...	...	...	...	...	11	11
	Pristis cuspidatus ...	1912 ...	...	24	...	1913	...	...	...	...	2	...	4	...	..	30
	Saw-fish	1913 ...	5	63	...	1914	130	...	...	...	...	...	...	...	...	198
		1914 ...	...	79	113	1915	190	48	...	...	15	...	25	...	51	521
		Average ...	1	42	28		80	12	...	...	4	...	7	...	16	190
58	Velamin	1911 ...	2,248	341	20	1912	229	473	466	404	907	647	3,627	4,182	3,173	16,717
	Lethrinus nebulosus.	1912 ...	1,269	...	...	1913	886	1,402	2,575	1,975	1,381	594	732	2,804	2,300	15,918
	Sea-bream	1913 ...	953	928	...	1914	727	866	991	1,728	2,260	1,271	836	5,040	4,352	19,952
		1914 ...	1,862	591	749	1915	438	432	3,096	2,763	1,507	2,476	3,513	1,787	4,338	23,552
		Average ...	1,583	465	192		570	793	1,782	1,718	1,514	1,247	2,177	3,453	3,541	19,035

59	Vengadai	1911	...	70	16	...	1912	...	...	...	...	...	...	...	...	...	86
	Caranx rottleri ...	1912	...	...	...	...	1913	...	...	...	10	...	95	...	...	14	119
	Horse-mackerel ...	1913	...	118	335	261	1914	45	42	19	110	80	230	105	33	...	1,378
		1914	...	...	313	148	1915	190	203	141	113	108	97	216	177	47	1,747
		Average	...	47	166	102		59	61	40	58	47	106	79	53	15	833
60	Venganai	1911	...	232	140	...	1912	1,182	1,094	...	...	...	...	...	...	1,237	3,885
	Pellona $\frac{\text{indica}}{\text{brachysoma}}$	1912	...	2,420	666	282	1913	503	...	...	...	...	398	583	28	425	5,305
	Sardine	1913	...	1,193	521	294	1914	1,124	824	273	164	38	40	...	41	452	4,964
		1914	...	1,735	1,327	714	1915	491	341	255	70	32	2	...	6	478	5,451
		Average	...	1,395	663	323		825	565	132	58	17	110	146	19	648	4,901
61	Miscellaneous ...	1911	...	69	24	..	1912	...	...	...	84	2	19	...	..	4	202
		1912	...	..	...	...	1913	2	100	..	9	71	1	...	...	32	215
		1913	...	101	530	75	1914	109	136	60	...	827	248	...		...	2,086
		1914	...	16	19	208	1915	1,363	359	103	111	144	314	236	146	288	3,307
		Average	...	46	143	71		369	149	41	51	261	145	59	36	81	1,452
62	Amai	1911	...	150		...	1912	...	..	...	400	...	...	...	...	235	785
	Turtle	1912	...	150	215	...	1913	...	74	150	136	245	241	132	240	90	1,673
		1913	...	251	...	...	1914	...	...	345	120	70	...	...	...	1,124	1,910
		1914	...	225	132	100	1915	68	...	460	...	120	245	226	576	62	2,214
		Average	...	194	87	25		17	18	239	164	109	122	89	204	378	1,646
63	Iral	1911	...	...	...	...	1912	...		...	4	..	...		...	96	100
	Penaeus carinatus.	1912	...	...	...	...	1913	...	...	...	..	..	...	6	15	77	98
	P. indicus and P. affinis.	1913	...	60	128	..	1914	...	...	47	18	...	...	213	383	5	854
		1914	...	181	1,424	1,021	1915	1,528	1,148	1,240	681	487	461	357	343	663	9,534
	Prawns	Average	...	60	388	255		382	287	322	176	121	115	144	185	211	2,646

TABLE II.—Detailed tabulation of the monthly catches of 61 kinds of fish, etc., landed at Tuticorin during the four years 1911—15—*concld.*

Number.	Name.	Year.	October.	November.	December.	Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Totals.
			LB.	LB.	LB.		LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LBS.	LB.
64	Kadal-panri ...	1911 ...	...	...	...	1912	...	...	...	...	...	...*	...	...	...	.
	Halicore dugong ...	1912 ...	280	...	...	1913	...	...	...	...	...	...	...	...	...	280
	Dugong	1913 ...	..	...	...	1914	...	...	...	..	...	...	224	...	...	224
		1914 ...	...	...	210	1915		..	...	...	...	128	...	...	393	731
		Average ...	70	...	53		...	...	...	...	...	32	56	..	98	309

* Weight not given.

TABLE III.—Detailed tabulation of weight and value of the catches of fish landed month by month at Tuticorin during the four years 1911—15 classified according to the method of capture.

Method.	Year.		October.	November.	December.	Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Totals.
Vāla Valai ...	1911	Weight ... Lb.	7,945	11,336	5,116	1912	15,809	12,911	5,070	9,357	132,283	31,894	20,547	15,056	6,001	273,325
		Value ... Rs.	572	786	324		951	789	304	651	3,804	2,048	1,597	1,572	282	13,680
	1912	Weight ... Lb.	757	3,197	12,288	1913	21,835	14,582	15,039	43,623	45,309	35,592	29,214	3,013	3,009	227,458
		Value ... Rs.	36	147	906		1,726	887	969	2,626	2,962	3,659	2,834	273	243	17,268
	1913	Weight .. Lb.	3,755	2,288	2,531	1914	16,223	6,877	11,900	13,976	27,036	189,130	24,270	7,192	769	305,947
		Value ... Rs.	342	196	299		1,355	617	904	1,126	2,105	10,404	2,040	699	45	20,132
	1914	Weight ... Lb.	...	3,196	3,746	1915	11,728	12,540	5,118	2,561	26,842	15,167	43,553	10,362	3,730	138,543
		Value ... Rs.	...	346	343		839	797	351	275	2,366	1,451	4,839	1,168	372	13,147
Average ...	...	Weight ... Lb.	3,114	5,004	5,920		16,399	11,728	9,282	17,379	57,867	67,946	29,396	8,906	3,377	236,318
		Value ... Rs.	238	369	468		1,218	773	632	1,169	2,809	4,390	2,828	928	235	16,057
Kola Valai ...	1911	Weight ... Lb.	3,659	...	...	1912	17,854	4,650	1,938	1,210	50	...	125	255	581	30,322
		Value ... Rs.	282		.		640	223	66	85	1	...	12	19	22	1,350
	1912	Weight ... Lb.	5,499	6,148	1,560	1913	3,102	318	...	...	...	...	458	2,897	11,606	31,588
		Value ... Rs.	287	197	95		140	8	..	...	...	...	32	223	636	1,618
	1913	Weight ... Lb.	14,748	10,606	2,317	1914	6,550	5,400	3,253	1,885	...	...	...	2,175	15,323	62,257
		Value ... Rs.	983	674	155		403	347	204	105	...	...	..	198	759	3,828
	1914	Weight ... Lb.	10,253	1,894	2,110	1915	7,726	3,803	...	...	...	...	...	1,134	5,578	32,498
		Value ... Rs.	619	126	165		460	174		...	...	...	...	59	231	1,834
Average ...	...	Weight ... Lb.	8,540	4,662	1,497		8,808	3,543	1,297	774	12	...	146	1,615	8,272	39,166
		Value ... Rs.	543	249	104		411	188	67	47	..	...	11	125	412	2,157
Mādi Valai ...	1911	Weight ... Lb.	10,897	13,160	7,022	1912	27,205	11,646	14,609	11,918	1,804	..	...	...	397	98,658
		Value ... Rs.	705	746	437		1,529	651	710	592	109	...	...	...	13	5,492
	1912	Weight ... Lb.	190	6,540	10,043	1913	6,245	19,587	13,233	11,214	3,133	155	193	568	121	71,222
		Value ... Rs.	10	263	674		302	739	585	463	208	7	10	40	6	3,307

TABLE III.—Detailed tabulation of weight and value of the catches of fish landed month by month at Tuticorin during the four years 1911—15 classified according to the method of capture—*concld.*

Method.	Year.		October	November.	December.	Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Totals.
Mădi Valai ...	1913	Weight ... Lb.	319	433	4,703	1914	8,725	6,311	10,755	7,509	276	...	...	...	2,056	41,087
		Value ... Rs.	16	41	416		777	562	652	275	16	...	...		72	2,827
	1914	Weight .. Lb.	294	2.624	3,662	1915	12,403	8,381	4,320	3,641	220	317	252	694	450	37,258
		Value ... Rs.	20	238	344		725	556	281	256	15	18	24	30	16	2,523
Average ...	...	Weight ... Lb.	2,925	5,689	6,358		13,644	11,481	10,729	8,571	1,358	118	111	316	756	62,056
		Value ... Rs.	188	322	468		833	627	557	397	87	6	8	17	27	3,537
Offshore lining.	1911	Weight ... Lb.	11,645	...	...	1912	945	975	2,107	5,857	5,180	2,317	5,725	18,031	17,172	69,954
		Value ... Rs.	803	..	...		63	66	148	527	705	238	625	1,366	1,618	6,159
	1912	Weight ... Lb.	13,673	...	72	1913	4,670	8,016	16,323	12,982	9,259	2,056	2,632	15,905	39,263	124,851
		Value ... Rs.	949	...	5		343	601	1,099	904	761	268	282	1,250	2,667	9,129
	1913	Weight ... Lb.	15,635	6,149	...	1914	9,636	14,788	11,208	8,858	10,595	3,175	2,466	27,111	30,368	139,989
		Value ... Rs.	1,077	454	...		894	1,152	811	720	783	192	262	1,969	2,035	10,349
	1914	Weight . Lb.	19,563	6,695	8,611	1915	8,748	8,058	13,725	15,718	9,979	7,746	11,611	10,816	13,793	135,063
		Value ... Rs.	1,348	485	659		672	707	1,261	1,363	1,113	966	1,989	1,356	2,534	14,453
Average ...	...	Weight ... Lb.	15,129	3,211	2,171		6,000	7,959	10,841	10,854	8,753	3,823	5,608	17,966	25,149	117,464
		Value ... Rs.	1,044	235	166		493	632	830	878	840	416	790	1,485	2,214	10,023
Inshore lining.	1911	Weight ... Lb.	3,446	13,064	18,158	1912	47,185	32,412	22,556	...	...	2,645	4,443	...	...	143,909
		Value ... Rs.	247	888	1,027		3,459	1,833	1,508	...	...	165	316	...	...	9,443
	1912	Weight ... Lb.	...	30,036	21,046	1913	30,680	10,865	2,434	701	151	4,580	3,518	1,362	...	105,373
		Value ... Rs.	...	1,635	1,283		1,711	620	145	50	16	379	298	106	...	6,243
	1913	Weight ... Lb.	4,156	5,641	14,273	1914	15,337	12,460	9,839	1,919	1,205	9,730	4,507	...	.	79,067
		Value ... Rs	242	451	1,098		1,152	875	590	126	80	507	439	...	...	5,560

	1914	Weight ... Lb.	211	10,298	8,374	1915	9,885	7,765	7,231	1,316	...	386	907	...	...	46,373
		Value ... Rs.	18	346	777		740	552	496	132	.	53	85	...	...	3,699
Average ...	...	Weight ... Lb.	1,953	14,760	15,463		25,772	15,876	10,515	984	339	4,335	3,344	340	...	93,681
		Value ... Rs.	127	955	1,046		1,766	970	685	77	24	276	284	26	...	6,236
Trolling ...	1911	Weight ... Lb.	460	15,970	5,446	1912	1,063	793	511	...	...	195	..	...	...	24,438
		Value ... Rs.	106	1,311	612		119	75	48	...	..	23	...	...	...	2,294
	1912	Weight ... Lb.	...	2,498	3,451	1913	4,501	537	...	...	710	...	..	...	138	11,835
		Value ... Rs.	..	282	331		476	77	...	...	46	...	.	...	8	1,220
	1913	Weight ... Lb.	1,466	14,270	12,967	1914	4,310	216	256	...	...	...	135	..	53	33,673
		Value ... Rs.	161	1,248	1,480		552	30	31	...	.	...	14	...	3	3,519
	1914	Weight ... Lb.	2,341	8,732	5,681	1915	4,716	2,297	1,099	...	...	...	...	...	.	24,866
		Value ... Rs.	258	1,081	704		733	371	144	...	...	...	...	...	...	3,291
Average ...	...	Weight ... Lb.	1,067	10,367	6,886		3,647	961	467	...	177	49	34	...	48	23,703
		Value ... Rs.	131	981	782		70	138	56	...	11	6	3		3	2,581
Minor nets ...	1914	Weight ... Lb.	4,396	6,259	4,751	1915	6,902	5,931	4,689	2,511	2,542	2,660	2,663	1,574	3,907	48,785
		Value ... Rs.	374	566	436		504	348	290	203	235	240	203	102	193	3,694
Fish bought at sea.	1911	Weight ... Lb.	12,972	384		1912	...	282	3,728	...	...	...	..	...	13,452	30,818
		Value ... Rs.	908	24	...		.	29	156	...	...	...	...	...	721	1,838
	1912	Weight ... Lb.	11,231	18,071	240	1913	...	1,304	2,655	3,835	...	...	247	9,123	18,690	65,366
		Value ... Rs.	516	745	14		...	91	67	88	...	...	26	591	1,256	3,394
	1913	Weight ... Lb.	13,568	6,159	8,552	1914	1,976	...	1,730	...	...	...	..	7,113	966	40,064
		Value ... Rs.	1,007	430	601		141	...	110	...	...	...	...	479	70	2,838
	1914	Weight ... Lb.	4,330	14,183	6,142	1915	2,643	1,229	1,780	32	...	...	...	...	3,060	33,399
		Value ... Rs.	352	1,100	548		140	79	116	2	...	...	...	...	168	2,505
Average ...	...	Weight ... Lb.	10,525	9,699	3,733		1,155	704	2,473	967	...	...	62	4,059	9,042	42,419
		Value ... Rs.	696	575	291		70	50	112	22	...	...	6	268	554	2,644

TABLE IV.—Summary of the annual weight and value of fish landed at Tuticorin for the four years 1911—15 classified according to the method of capture.

—	Vāla valai.		Kola valai.		Mādi valai.		Offshore lining.		Inshore lining.		Trolling.		Minor nets.		Fish bought at sea.		Totals.	
	Lb.	Rupees.	Lb.	Rupees.	Lb.	Rupees.	Lb.	Rupees.	Lb.	Rupees.	Lb.	Rupees.	Lb.	Rupees.	Lb.	Rupees.	Lb.	Rupees.
October 1911 to September 1912.	273,325	13,680	30,322	1,350	98,658	5,492	69,954	6,159	143,909	9,443	24,438	2,294	...	...	30,818	1,838	671,424	40,256
October 1912 to September 1913.	227,458	17,268	31,588	1,618	71,222	3,307	124,851	9,129	105,373	6,243	11,835	1,220	...	...	65,396	3,394	637,723	42,179
October 1913 to September 1914.	305,947	20,132	62,257	3,828	41,087	2,827	139,989	10,349	79,067	5,560	33,673	3,519	...	. .	40,064	2,838	702,084	49,053
October 1914 to September 1915.	138,543	13,147	32,498	1,834	37,258	2,523	135,063	14,453	46,373	3,699	24.866	3,291	48,785	3,694	33,399	2,505	496,785	45,146
Average ...	236,318	16,057	39,166	2,157	62,056	3,537	117,464	10,023	93,681	6,236	23,703	2,581	48,785	3,694	42,419	2,644	627,004	44,158

TABLE V.—Average monthly and annual quantity of the produce of the chief fishing methods employed at Tuticorin over the four years' period 1911—15.

Method.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Totals.
	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.
1. Vāla Valai ...	3,114	5,004	5,920	16,399	11,728	9,282	17,379	57,867	67,946	29,396	8,906	3,377	236,318
2. Kola Valai ...	8,540	4,662	1,497	8,808	3,543	1,297	774	12	...	146	1,615	8,272	39,166
3. Mādi Valai (with fish bought at sea).	13,450	15,388	10,091	14,799	12,185	13,202	9,538	1,358	118	173	4,375	9,798	104,475
4. Offshore lining ...	15,129	3,211	2,171	6,000	7,959	10,841	10,854	8,753	3,823	5,608	17,966	25,149	117,464
5. Inshore lining ...	1,953	14,760	15,463	25,772	15,876	10,515	984	339	4,335	3,344	340	...	93,681
6. Trolling	1,067	10,367	6,886	3,647	961	467	...	177	49	34	...	48	23,703
7. Minor nets ...	4,396	6,259	4,751	6,902	5,931	4,689	2,511	2,542	2,660	2,663	1,574	3,907	48,785
Total ...	47,649	59,651	46,779	82,327	58,183	50,293	42,040	71,048	78,931	41,364	34,776	50,551	663,592

TABLE VI.—Average monthly and annual value of the produce of the chief fishing methods employed at Tuticorin over the four years' period 1911—15.

Method.	October.	November.	December.	January.	February.	March.	April.	May	June.	July.	August.	September.	Totals.
	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.
1. Vāla Valai ...	238	369	468	1,218	773	632	1,169	2,809	4,390	2,828	928	235	16,057
2. Kola Valai ...	543	249	104	411	188	67	47	...	...	11	125	412	2,157
3. Mādi Valai (with fish bought at sea).	884	897	759	903	677	669	419	87	6	14	285	581	6,181
4. Offshore lining ...	1,044	235	166	493	632	830	878	840	416	790	1,485	2,214	10,023
5. Inshore lining ...	127	955	1,046	1,766	970	685	77	24	276	284	26	...	6,236
6. Trolling	131	981	782	470	138	56	...	11	6	3	...	3	2,581
7. Minor nets ...	374	566	436	504	348	290	203	235	240	203	102	193	3,694
Total ...	3,341	4,252	3,761	5,765	3,726	3,229	2,793	4,006	5,334	4,133	2,951	3,638	46,929

TABLE VII.--Diagram showing graphically the relative monthly importance of the ten principal food-fishes landed at Tuticorin over an average of four years ending September 1915.

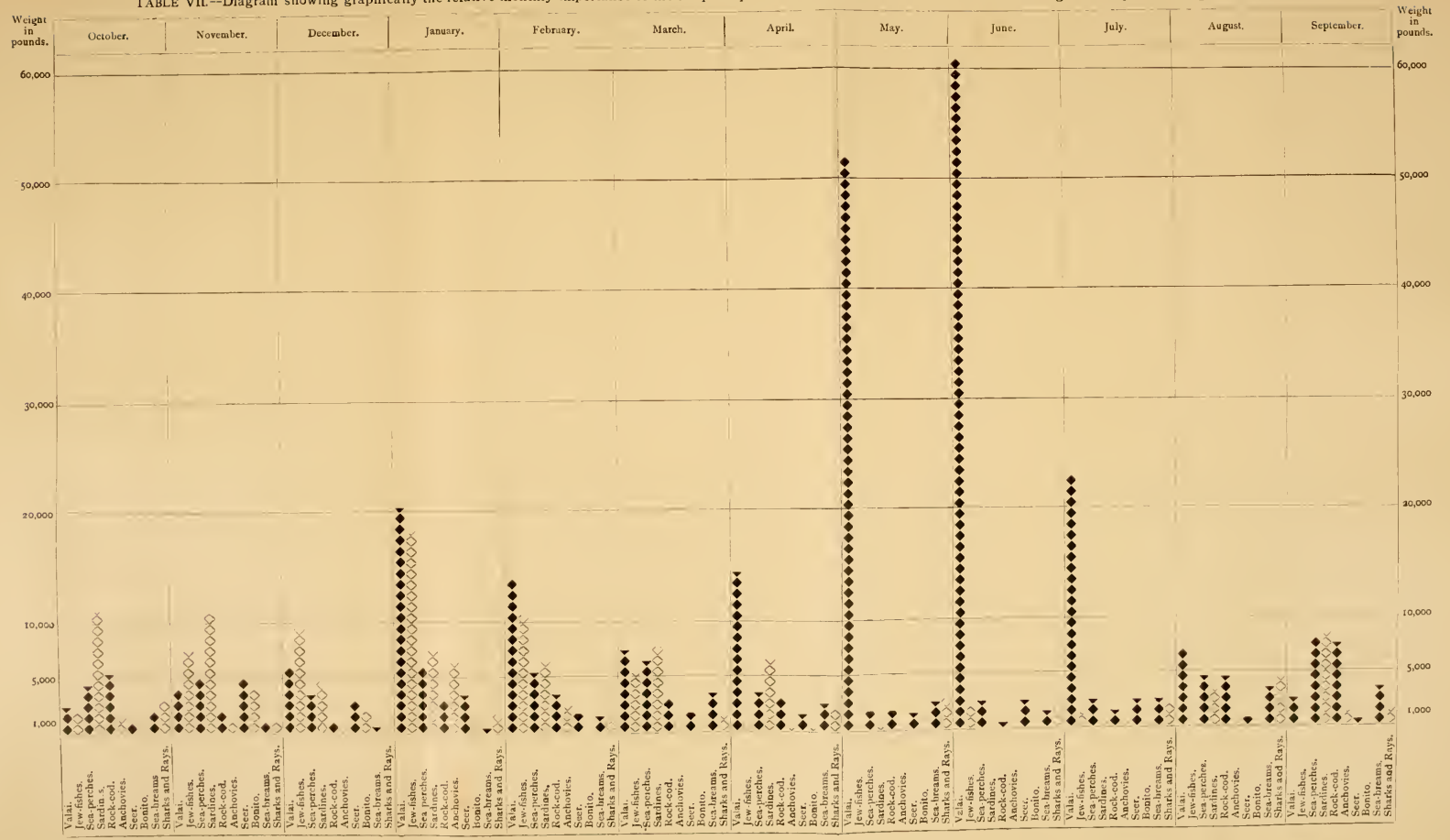


TABLE VIII.—Diagram showing graphically the comparative weight and value per annum of 36 kinds of food-fishes landed at Tuticorin, based on the averages of four years' records, 1911—15.

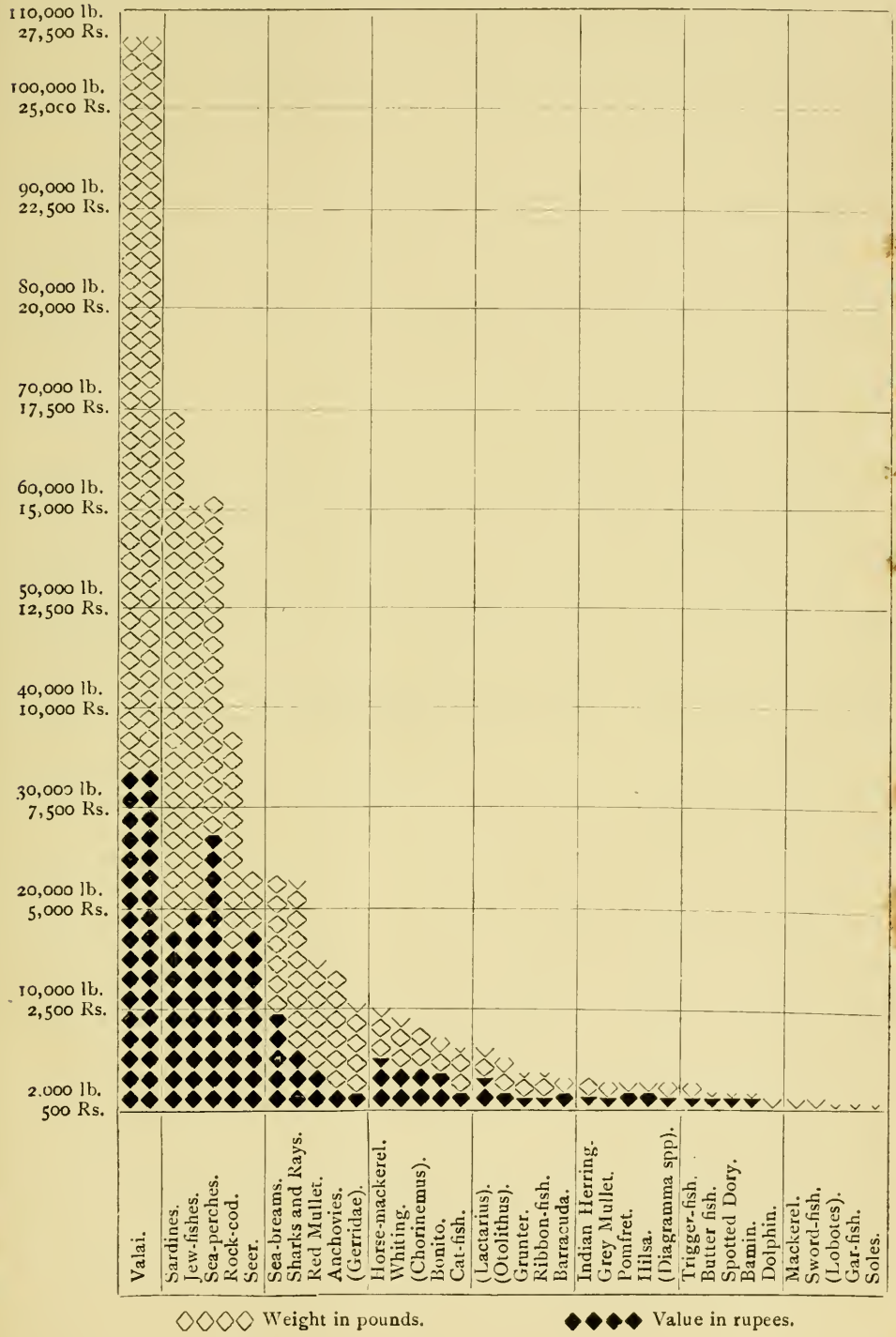
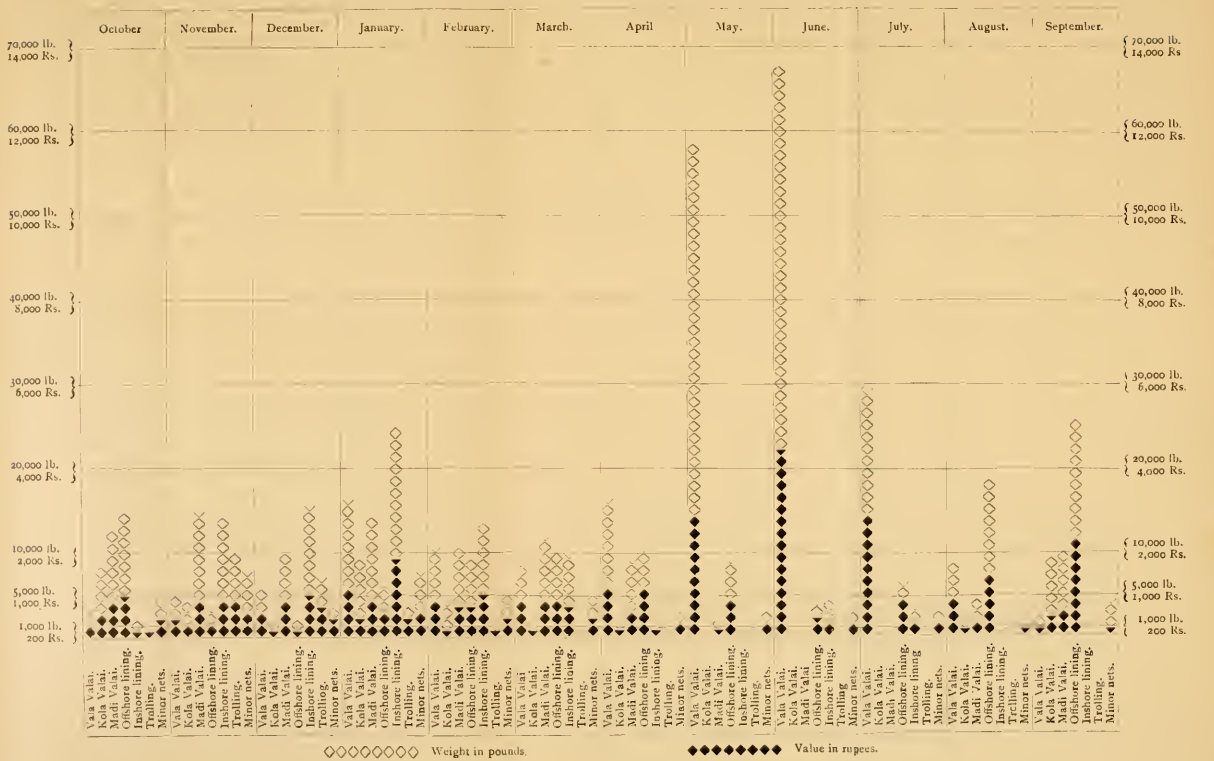


TABLE IX.—Diagram showing graphically the seasons and relative productive value of the seven principal methods of fishing practised off Tuticorin, based on the averages of four years' records, 1911—15.



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THE INDIAN BÊCHE-DE-MER INDUSTRY:

ITS HISTORY AND RECENT REVIVAL

BY

JAMES HORNELL, F.L.S.,

Government Marine Biologist, Madras.

Report No. 4 (1917),

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THE INDIAN BECHE-DE-MER INDUSTRY: ITS HISTORY AND RECENT REVIVAL,

BY

JAMES HORNELL, F.L.S.,
GOVERNMENT MARINE BIOLOGIST, MADRAS.

Bêche-de-mer, also known widely as *trepang*, is the commercial name of a marine food product held in great esteem among the Chinese. It consists of the dried body-wall of certain species of large Holothurians, a group of animals known popularly in England as sea-cucumbers owing to their characteristic cylindrical or sausage-like shape, and intimately related to sea-urchins and starfishes in spite of the great dissimilarity in outward form. Hence the group belongs to that assemblage of animals known zoologically as Echinodermata.

The term *bêche-de-mer* is the French rendering of the Portuguese name *bicho-do-mar*, signifying sea-slug; in Tamil it is known as *attai* or leech, this being more familiar to Indians than the slug.

HISTORY OF THE TRADE IN INDIA.

The cured product has been from time immemorial a valued Chinese delicacy; strangely enough appreciation of its flavour has never spread to the epicures of other races, and all but an infinitesimal amount of the total production is consumed by the Chinese at home and abroad. In its quest the Chinaman has penetrated alike to the shores of Southern India and to the lagoons of Polynesia, and from Japan in the north to Australia in the south he has pioneered the trade and introduced appropriate curing methods. We know that the Chinese had constant trade with Southern India and with Ceylon a full thousand years ago, maintained by junks of large size and fine equipment; so numerous and large were the vessels of their trading fleet that on one occasion it transported a Chinese army to Ceylon which defeated the Sinhalese

and captured the King.[1] With traffic maintained by means of the annual trade fleet it may be presumed with tolerable certainty that bêche-de-mer as well as pearls figured among the Indian products received at the Pandyan port of Kayal in exchange for the porcelain, silks, and sweetmeats of the Middle Kingdom. Coming to British days the earliest definite reference to the trade which I have found is an offer to Government made in 1816 by a certain Mr. Wilkins for the whole of the bêche-de-mer fished off Mannar in Ceylon.[2] Doubtless the Dutch records in India and Ceylon contain more definite information, but these are not readily available to me.

Tradition affirms that formerly the trade was much greater than at present and the statistics supplied by the Customs Department bear this out generally as will be seen from the table given opposite.

[1] The Sinhalese chronicle *Rajawaliya*, gives the date as 1958 of the Buddhist era, equivalent to 1415 A.D.

[2] Boake, W.J.S., "Mannar, a monograph," p. 52, Colombo, 1888.

STATISTICS of the imports and exports of Bêche-de-mer for the Madras Presidency from 1898 to 1916 as shown by the customs returns.

Year.	Exports from Madras Presidency.								Imports into Madras Presidency.				Remarks.
	To Straits Settlements.				To Ceylon.				From Ceylon.		From Straits Settlements.		
	Foreign Produce.		Indian Produce.		Foreign Produce.		Indian Produce.						
	Weight in lb.	Value in rupees.	Weight in lb.	Value in rupees.	Weight in lb.	Value in rupees.	Weight in lb.	Value in rupees.	Weight in lb.	Value in rupees.	Weight in lb.	Value in rupees.	
1898-1899 ...	...	...	56,896	15,380	...		...	...	16,639	7,428	...	...	The imports from Ceylon in 1898-99 appear to have been re-exported as Indian produce.
1899-1900	8,232	2,940	3,192	1,140	...	...	...		19,935	8,227	..	..	The Indian produce exported during these years is wrongly classed as foreign produce being lumped with Ceylon re-exports (J.H.).
1900-1901 ...	...	...	...	...	..			...	10,976	4,798	...	...	
1901-1902 ...	22,176	9,045	...	...	4,368	1,560	...	...	30,491	12,773	...	...	
1902-1903 ...	13,888	7,340	...	...	22,512	10,050	...		21,700	7,745		...	
1903-1904 ..	19,824	9,743	..	...	...	...	13,272	4,740	17,416	7,340	...		
1904-1905 ...	336	120	32,284	15,203	...	...	...	...	13,272	4,740	.	...	The converse has happened here, all the exports from Ceylon being classed as Indian produce upon re-export (J.H.).
1905-1906 ...	...	..	68,544	24,300	...	.			18,080	3,460	56	5	
1906-1907 ...		...	6,944	3,100	...	..	29,568	9,660	...		...	...	
1907-1908	...	...	22,204	8,460	...	...	..	...	36,949	7,979	...		
1908-1909 ...	...	...	28,352	7,020	...	...	. .	...	28,933	5,213	...	..	
1909-1910 ...	...	...	18,732	5,039	..	...	...	...	10,720	1,477		.	
1910-1911 ...	...	...	2,716	655	...	..	...	...	...	...	...	...	
1911-1912 ...	.	...	6,272	860	...	...	...	...	..	..	...	...	
1912-1913 ..	...	...	1,120	596	...	...		...	...	...	...	..	
1913-1914 ...	...	...	3,024	600	...	...	...	..		...	...	...	
1914-1915 .	...	...	...	...	...	..	...	...	...	. .	...	...	
1915-1916 ...	...	...	4,816	1,426	...	...	...		..		...	...	
Total ...	64,456	29,188	255,096	83,719	26,880	11,610	42,840	14,400	225,171	71,180	56	5	

In this table considerable confusion exists however and the value of the statistics is discounted by very obvious errors in the statement of the country of origin of the goods exported. From these returns it is seen that prior to 1910–11 a large proportion of the Ceylon produce was sent to India for re-export to China, but in almost all cases exporters have failed to classify properly the goods shipped from India. Thus from 1901–02 to 1903–04, the whole export was described as "Foreign produce," whereas from 1904–05 to 1909–10 inclusive the imported Ceylon produce has been lumped with the home produce as "Indian produce"; in the latter period of six years 107,954 lb. weight was imported into India from Ceylon, but the Customs tables show only 336 lb. of foreign produce exported from India, an evident absurdity, seeing that not an ounce of this material is consumed in India. The missing 107,618 lb. have been undoubtedly included in the exports of 206,628 lb. of so-called Indian produce shown by the Customs tables. We are consequently unable to ascertain the actual annual production and export of the Indian-cured product during the years 1898—1910. Only from 1910 have we accurate annual data as no Ceylon produce has been imported (for re-export) into India since that year. Without the above explanation the Customs returns prior to 1910 give an altogether misleading record of the condition of this trade, one more instance of the unsatisfactory nature of such statistics when not prepared and checked by trade experts.

The only useful result we can arrive at by analysis is to note that the total exports (including re-exports) from India for the twelve years from 1898 amounted to 371,324 lb.; deducting the total imports for this period of 225,227 lb. we get a balance, representing approximately the actual Indian home production of 146,097 lb. giving an average of 12,175 lb. per annum for the twelve years in question. Since 1910 the annual Indian export has diminished to 2,991 lb., a very great falling off.

The knowledge of this great diminution in the production coupled with information obtained in 1915 that the local merchants were suspending their operations, owing partly to difficulties and uncertainties induced by war conditions, and partly by alleged reduction in the wholesale rates ruling in the Straits—Penang being the port to which the local merchants usually ship their goods—caused me to undertake an enquiry into the condition and

prospects of the industry. The result, while confirming the exporters' statements of poor prices prevailing for their goods, revealed the fact that the main reason lay in a deterioration in quality, due to a fault very prevalent I am sorry to say among Indian manufacturers, to wit, the scamping of essential processes in over-eagerness for immediate large profit and in a gradual deviation from the original methods of preparation introduced by Chinese curers. The history of the trade so far as I can see is one of definite fluctuations. First comes a Chinese merchant-curer who establishes a curing-station on the Palk Bay coast of the Ramnad district, engages labour and buys the raw product from the local divers. He works conscientiously in Chinese fashion, giving constant supervision and insisting on approved methods being followed, and, where need be, improving upon them. His product is first-class, obtains good prices in Penang, Singapore or China, and he begins to wax prosperous and extend his enterprise. Here after a few years enters the Muhammadan merchant of Kilakarai; he has watched the Chinaman develop (or revive the trade), has obtained knowledge of the curing methods pursued and the general course of the trade, and forthwith determines to oust the Chinaman and appropriate his business. So the next season the Chinaman finds a rival curing-station opened; he finds his trade gone in a day and has no alternative but to seek some other stage for the exercise of his talents. But why, it may be asked, does he give in without a struggle? Why! because his rival has such effective methods of influencing the divers of the local coast villages that an outlander has no chance. The divers are probably already heavily in debt to this merchant or to one of his relatives or friends for advances made for work in the Chank Fishery which is usually carried on concurrently with the bêche-de-mer fishery, and a gentle turn of the debt-screw is all that is necessary to enforce compliance with any boycott that may be ordered against the stanger. Upon the departure of the Chinese curer, the curing staff, being the same men as he employed, carry on according to his methods and all goes well for a few years. Then little by little carelessness and deviation in detail creep into the conduct of the work and deterioration in the quality of the product begins to be found by the Chinese buyers in the consignments received. The Indian product falls in estimation and eventually into such bad odour (figuratively and actually) that the

prices given prove unremunerative to the Indian exporter and the trade dies out or languishes. Then after a longer or shorter period another Chinese curer appears on the scene who revives the trade and sets it on its feet again by the employment of honest and careful methods.

The last time a Chinaman operated on the Ramnad coast was some 30 years ago according to my informants. He passed duly through the experience I have outlined above and the trade had reached its ebb in 1916 when I came on the scene as a variant of the periodical Chinaman. I had already some knowledge of the curing processes and I was soon in a position to put my finger upon the irregularities which had caused the Indian product to become unsaleable at remunerative prices. Before enumerating these I shall furnish some details of the species esteemed and of the approved methods evolved by Chinese curers for the proper preparation of the Indian raw material.

THE CHIEF SPECIES CURED.

The only species of Holothurian found by the Chinese suitable and sufficiently abundant for conversion into bêche-de-mer on the Ramnad coast is the one known locally as *vellai attai* or white bêche-de-mer. This I have identified as the species known to zoologists as *Holothuria scabra*, Jaeger. It grows to a large size, often 12 to 15 inches long, with a girth of 6 to 7 inches. Although nearly cylindrical, there is a slight flattening of the side upon which it lies habitually, and this part is snowy white dotted with many minute black specks; the upper side or back is crossed by irregular light bands and bars—white, pale-yellow, or grey—outlined in dark grey upon a ground colour of paler grey. In its skin are enormous numbers of minute limy spicules scarcely visible when extracted even as very fine dust except with the aid of the microscope. The only other species sufficiently abundant to be commercially dealt with are the "green prickly-fish" (*mul attai*, i.e., thorn-attai) and the "black-fish." The latter is very numerous on the reef-flats of the coral islands along the Ramnad and Tinnevelly coast, but owing to the thinness of its body-wall it shrinks so greatly in curing as to be difficult to handle commercially, particularly as its intrinsic value is very low even when sold by weight. This species I identify as *Holothuria atra*, Jaeger, while the "green prickly-fish" is the well-known *Stichopus chloronotus*,

Brandt. It is not so abundant as either the white or the black species but is fairly common on weedy bottom in Rameswaram bay. It has no present commercial value, owing to the gelatinous nature of the body-wall, which dissolves into a glutinous mass soon after death.

Saville-Kent in *The Great Barrier Reef of Australia*, page 239, has suggested that this and other similar soft-bodied species might possibly be susceptible of cure if placed in strong brine or other astringent immediately after capture. Experiments have recently been made in this direction at Rameswaram, and I am able to report that I have found it possible to carry the material successfully through the boiling process. Unfortunately this does not help, for the subsequent dryage reduces even large animals to microscopic proportions. The final verdict confirms the current opinion that this species has no commercial value. Curiously enough, the most valued of the Australian species of bêche-de-mer is the closely allied "red prickly-fish" (*Stichopus variegatus*, Semper), with a market value that once varied between £130 to £150 (Rs. 1,950 to Rs. 2,250) per ton.

With the white bêche-de-mer fished off the Ramnad coast are a very few "red-fish" (*Holothuria spinifera*, Theel). This is mixed with the former in curing. Its quality and appearance are first-class and were it obtainable in quantity and could be sold separately, it would fetch a much higher price than the "white-fish."

THE CHINESE CURE OF THE INDIAN WHITE BÊCHE-DE-MER.

For practical purposes *Holothuria scabra*, otherwise *vellai attai* or white bêche-de-mer, is the only Indian species that counts in the eyes of the Chinese curers, as being both abundant and capable of being converted into a satisfactory product. It appears however not to be a species in any esteem in the Malay Archipelago where it also occurs and where other species monopolise commercial attention.[1] The reason is that it requires special methods of cure and these appear to have been evolved and practised only in India, as already mentioned. This species has an enormous abundance of limy spicules in its skin and unless these be removed the product when dried appears as if caked with chalk; indeed it is to all

[1] It is not recorded by Saville-Kent in his list of Australian species unless it be his *Holothuria edulis*. (*Great Barrier Reef of Australia*, London, 1893.)

intents a chalky coat as it consists wholly of calcareous spicules. In other countries the coating being left on the product renders it of very low market value. Saville-Kent (*loc. cit.*, page 233) says of the Australian "sand-fish" (his *Holothuria fusco-cinerea*, *H. edulis* and *H. impatiens*) that in these this chalky coat is so abundantly developed that it is possible to utilize the dried bodies, like chalk, for marking purposes. He adds that when mixing these "sand-fish" with other more valuable species the subterfuge is not infrequently resorted to of dyeing their bodies a deep red-brown in a decoction of the bark of the red mangrove, *Rhizophora mucronata*. Thus treated they are not easily detected, when mixed in bulk, from the poorer descriptions of ordinary red-fish.

It is one of these disparaged species with which we have to deal in India; the following is the method of preparation as worked out by the Chinese curers:—The animals as soon as possible after they are brought to the curing station are heaped up in shallow cauldrons supported on mud walls over fires fed with leaf-butts of palmyra leaves. No water is added as it is found the animals expel a sufficiency from within their bodies as they feel the heat and contract. A furious fire is kept going and in about fifty minutes the animals have shrunk to about one-half their original length and have begun to give out a distinctive cooked odour. At this stage they are removed and buried in a shallow pit dug in the sand close to the water's edge. Sand is heaped over and a plentiful amount of sea-water thrown on the sand in order that the buried material may be kept moist and run no risk of drying up. Here the bêche-de-mer remains usually 12 to 18 hours or even more according to size. When judged sufficiently "ripe," the bodies are disinterred and removed to a large basket about 2½ feet in depth by about the same diameter. As they are lifted one by one the curer's thumb is run over the surface, loosening and dislodging much of the chalky encrustation. If the material has not been buried sufficiently long, this coat adheres too strongly and will not yield a satisfactory result when dried. As soon as the basket is half filled a curer jumps in and proceeds to tramp upon the filthy-looking mass, the while an assistant pours in successive bucketsful of sea-water. If the period of burial has been judged aright, the surface layer containing the chalky spicules is sufficiently decomposed to peel off readily and leave the underlying thick connective tissue layers free from the original chalky deposit. After a final

rinse the cleaned product is put a second time into the boilers with enough sea-water to cover it and once again brought to boiling point. Thereafter it is laid out on mats and either dried wholly in the sun, or after partial drying it may be transferred to a very primitive and wasteful form of smoke-house and dried to completion over wood smoke. I should here mention that evisceration is effected naturally, the animals doing so after the approved Holothurian fashion through the vent, either when lying on the beach awaiting the curer's attention or when heated *en masse* in the boiler. No slitting open of the body is practised or needful.

Now this is not the method in use in Australia and Malaysia. There the process as described by Saville-Kent (*loc. cit.*, page 226) is as follows:—

"Immediately on their arrival at the depot or curing station, they are placed in large iron cauldrons and boiled for twenty minutes. They are next taken out; split up longitudinally with a long, sharp-pointed knife; gutted; and exposed on the ground in the sun until the greater portion of the moisture has evaporated. The largest specimens, such as prickly and teat-fish, are frequently spread-open, so as to dry more readily, with small transversly-inserted wooden splints. The greater amount of moisture having been got rid of, the fish are transferred to the smoke-house. This is usually composed of corrugated iron 10 or 12 feet high and fitted in its upper half with two or three tiers of wire netting upon which the bêche-de-mer are laid. The wood most in favour for the smoking process is that of the red mangrove. Twenty-four hours is the usual period for which bêche-de-mer are left in the smoke-house. By the end of that time they have for the most part shrunk to a length of six inches or less, and in aspect they may be likened to charred sausages. They are then ready for bagging up and despatch to the nearest market."

The Chinese who evolved the method now practised in India, showed great resource in adapting their methods to the treatment of a refractory subject and rendering valuable a material which otherwise would have been unprofitable to fish and cure. As showing how local the practice of this ingenious method is and how unknown it is further east, we have not only Saville-Kent's account as quoted above, but also the following extract of a letter received by me this year (1917) from Mr. Alvin Seale, lately

Director of the Fisheries Section of the Bureau of Science, Philippine Islands:—

"In reading your interesting lecture on the Minor Marine Industries, I was greatly astonished by the method you gave for preparing bêche-de-mer. You state 'no water is added' (in boiling) 'as they contain sufficient fluid within their bodies. When removed from the pan they are placed within a basket and well tramped in order to remove their skin.'"

"Now I have seen thousands of commercial trepang but I never have seen one with the skin removed—none are prepared in the Philippines or in Japan, or in Australia in this way, as I have watched the process very carefully in these places. I have also prepared quite a quantity myself, so I would like a little more detail regarding your method."

It is probable therefore that with the further particulars which I have supplied and the publicity that will follow upon the publication of this report, that the Indian method of treatment will be adopted in other bêche-de-mer producing countries and so enable species hitherto considered valueless to become of importance in the trade, and so form a small contribution to the extension of the food resources of the East.

DEFECTS IN CURE AND TRADE IRREGULARITIES.

When I began the investigation of this product in 1914, I found that the perfected Chinese methods were not being followed with precision; the product in consequence was inferior in quality. Further, the curers and exporters had evolved several clever but shortsighted sharp practices in the sophistication of the product, with the idea partly to increase the weight illegitimately and partly to pass considerable quantities of inferior quality into bags containing better grades.

The chief of these departures from proper practice and honest work were:—

(*a*) Faulty evisceration,

(*b*) Imperfect removal of the chalky dermal coating,

(*c*) Careless drying, entailing a dirty-looking product, much coated with sand,

(*d*) Reluctance to smoke the product in order to save the expense of fuel,

(*e*) The mixing of improper quantities of small stuff with the larger grades, and

(*f*) Storage for long periods, entailing deterioration while waiting for a good market.

The first three were the most productive of harmful consequences, but taken all together the cumulative effects were so serious that the reputation of the Indian cure had fallen so low that prices in 1914 were so unsatisfactory that the Kilakarai curers virtually retired from the trade.

Improper evisceration was probably the most potent factor in the discredit of this trade. It was by no means the result of carelessness, but was a deliberate move to increase the final weight. The present species of Holothurian feeds almost in the same way as earthworms; it has a series of somewhat scoop-shaped tentacles arranged around the mouth which is near the front end of the body, but turned downwards for convenience in sucking up the sand with the assistance of the scooping action of the tentacles. For nutriment these creatures depend upon the live organisms or other organic matter contained in the sand ingested, such as diatoms, foraminifera, radiolaria, fragments of seaweed and the like. Hence the intestines are always crammed with sand and if these be not fully removed by natural or by forced evisceration, a considerable quantity of sand remains within the body, adding to the weight—a well-known trade device in other Indian trades besides this. The imperfect removal of the outer chalky coating was perhaps not done intentionally; probably it was the result of carelessness and lack of supervision. Anyway it also added to the final weight and the dodge was occasionally resorted to of putting some black Holothurians (*H. atra*) into the pan during the second boiling in order that the dark purplish pigment contained in their skin might stain the chalky encrustation and render it inconspicuous. Compare the parallel dodge mentioned by Saville-Kent (*loc. cit.*, p. 233) practised in Australia of dyeing the chalk-coated "sand-fish" with mangrove bark decoction.

Another common trade trick was to slit open large animals and insert small ones in the cavity within. In a country where labour is cheap, such a method may be practised with great profit for a limited time as the trick is not readily detected until the article comes finally into the cook's hands.

Another great mistake tending to give the product a bad reputation was reluctance to expend fuel upon smoking. The chief, if indeed it be not the sole *raison d'etre* for smoking is to sterilize the

product, partly by impregnation and partly by covering it with an antiseptic coating whereof the effective agent is creosote contained in the wood smoke. The importance of this operation as affecting the keeping qualities of the product is not properly appreciated by Indian curers; consequently in the desire to make a maximum of profit, they smoke the stuff only when compelled to do so by a continuance of rainy weather and then only in order to get the material dry. *They make the mistake of considering the smoke house as an artificial dryer* and not as a sterilizing chamber. They look on smoking as an expensive substitute for sun drying. This defect in itself would not be serious, as I have proved commercially, if frequent periodical examination of the stored material be made, if it be spread out in the sun whenever any dampness be apparent, and if it be shipped to its destination in frequent parcels immediately enough be accumulated. But this is not the business method of local merchants. They will not send small lots for sale at frequent intervals owing to the somewhat higher ratio of charges involved thereby; they prefer to accumulate comparatively large quantities and to sit on this indefinitely—even for several years—waiting for advice from their Penang correspondents of the advent of high prices. During this lengthy storage, in spite of the general dryness of the climate on the Ramnad coast, the material sooner or later absorbs moisture and in the congenial conditions of damp and darkness, fermentative micro-organisms establish themselves in the material and rapidly entail marked deterioration. I have seen long-stored material dissolving into a black glutinous mass. When this happens, the owner reboils the material, thereby arresting fermentation and temporarily sterilizing the mass. Each reboiling reduces the weight and impairs the outward appearance, as the fermented portions dissolve in boiling water and leave ugly abscess-like cavities, which must tell their tale quite plainly to expert buyers.

THE STORY OF THE GOVERNMENT EXPERIMENTAL FACTORY.

Consequent upon the conclusions come to from my preliminary investigation of the industry in 1914–15, I felt that here was an industry, brought to discredit and ruin by careless work and short-sighted trade trickery, whereto Government effort might with propriety be devoted with the three-fold aim of reviving a decadent local industry, of perfecting the methods hitherto employed, and

of providing additional remunerative employment to the chank divers of the Ramnad district.

Accordingly I outlined proposals for the establishment of an experimental factory to be located at Tirupalakudi, the chief settlement of chank divers on the Palk Bay coast of the Ramnad district. Government sanctioned the scheme in G.O. No. 2739, Revenue, dated 9th December 1915, and as soon after as circumstances allowed, I constructed a store and a boiling shed to accomodate three cauldrons. I also designed a special smoke-kiln to hold eight trays made of expanded metal, at appropriate intervals one above the other. On August 6, 1916, actual operations began, after settling the rates to be paid with the divers of the place. The latter were very pleased with the step thus taken, for it gave them an additional string to their bow; on certain parts of the ground where they fish chanks, bêche-de-mer are also found and although the price provisionally fixed was low in view of the uncertainty prevailing as to the eventual sale proceeds of the cured material, it was sufficiently remunerative to mean an appreciable and welcome addition to their earnings. Then on certain days when diving was not possible in the deep-water beds, the men were able to make a living wage by fishing specifically for the smaller sizes found in great abundance in certain shallow water areas. Usually a few chanks were also found in these inshore beds and these were an additional source of profit both to the men and to Government. They would have remained unfished had no bêche-de-mer fishery been started.

The methods previously in vogue, stripped of their more obvious defects, were employed during the first season's work. Great care was exercised in denuding the animals of their chalky coat, and scrupulous cleanliness was enforced, particularly in the drying process. Further, in place of permitting the boiled material to be dried on mats, laid on sandy and often dirty ground, drying platforms raised 2½ feet above the ground level were erected, and on these were spread expanded-iron trays whereon the material was laid to dry. By this simple device, the drying period was considerably shortened and the animals were kept clean and free from the adherence of sand and dirt. The product in consequence was improved greatly in appearance, being obviously brighter and cleaner than material prepared after the more primitive method.

The importance of complete evisceration was not fully appreciated during the first season's work and as a consequence a certain portion of the material was dried with considerable quantities of sand enclosed within the body walls ; this undoubtedly affected adversely the value to some extent when put upon the market. Even with this partial defect, local opinion was emphatic that the cure was a marked improvement upon the quality turned out of recent years by the Kilakarai curers. This opinion received confirmation from the comparatively high prices eventually realized. During the current season special means are being taken to do away entirely with this defect by means of a partial slitting open of the body-wall before boiling, whereby perfect evisceration is obtained. The dried weight will be considerably reduced, but I have little doubt that purchasers will appreciate this improvement by paying higher rates. That the produce of the Government factory may be readily recognizable, a special trade brand has been adopted, and it is hoped that this will soon come to be known as a guarantee of prime quality and so become an asset of considerable importance.

During the initial season's working only a small quantity of material was smoked as the kiln was not ready at the beginning. This had no adverse financial consequence, for the Singapore brokers reported that it so happened at the time of the consignement's arrival that the market was bare of unsmoked material and as this, when of good quality, is preferred for purely local consumption, excellent prices were obtained as the buyers found the consignment clean, well-dried and generally to their liking. From this it would appear that so long as the consignments are small there is no objection—sometimes even an advantage—in a proportion of the material being sun-dried if in good condition otherwise ; such supplies the local markets of the Malay Peninsula, whereas smoked material, owing to its better keeping quality, is more suitable for re-export to China. It follows therefore that as the Singapore home consumption is limited, the larger be the consignments and the more frequent they be, will necessitate a larger proportion being sent in the smoked condition.

A point the bêche-de-mer curer must note carefully is that the boiled body juice of the material is exceedingly corrosive in its effect upon metal ; hence the boilers must be most carefully emptied and rinsed out with clean water at the end of each day's

operation. Any boiled juice left overnight in the pans, if this happens frequently, will quickly eat into the iron and destroy the pan in a short time. For the same reason copper or brass vessels and utensils must be rigorously avoided. A case is on record where a copper pan being used as a boiler, the bêche-de-mer boiled in it took up so much copper salts that several deaths resulted from its consumption in China and the particular grade fell in market value enormously from the discredit that thereby attached to it.[1]

The total outturn weights of the material cured from August to October 1916 were as follows:—

Large and medium sizes (Nos. I and II) ...	1,997 lb.
Small (No. III), including smoked	799 „
Total ...	2,796 lb.

COSTS AND CHARGES.

To descend to exact financial particulars, the operations at Tirupalakudi during the three months from August to October 1916, which may be reckoned as the first half-season, entailed expenditure as follows:—

Capital expenditure:—

	RS.	A.	P.
Cost of temporary buildings	77	5	3
„ of pans, trays, utensils, etc. ...	55	10	0
Total capital expenditure ...	132	15	3

Running charges:—

	RS.	A.	P.
No. I quality, 493 animals at 2 pies each	5	2	2
No. II quality, 43,797 animals at 1 pie each	228	1	3
No. III quality, 36,016 animals at 3 for 1 pie ...	62	4	3
	295	7	8
Labour (curer's and assistant curer's wages, etc.) ..	79	3	2
Fuel	70	7	9
Sundries	31	12	10
Supervision (half of the chank gumastah's wages for 6 months)	60	0	0
Total running charges ...	536	15	5

[1] Saville-Kent, *loc. cit.*, p. 239.

In addition, freight, insurance, and shipping charges amounted to Rs. 51-12-6. Against the total cost and charges amounting thus to Rs. 588-11-11, exclusive of capital expenditure, we received net sale-proceeds of Rs. 1,074-12-9, giving an apparent profit of Rs. 486-0-10 upon the operations; from this however must be deducted depreciation on buildings and apparatus, say 50 per cent upon the capital expenditure of Rs. 132-15-3; this being Rs. 66-7-8, we get as a final net profit the sum of Rs. 419-9-2, equal to a little over 63 per cent on the expenditure, which must be considered very satisfactory in view of the comparatively small quantity of material treated. With larger quantities, the percentage of profit would be substantially increased.

The selling rates obtained in January 1917 were as follows, c.i.f. Singapore :—

Unsmoked :—

	Per picul.	Per ton.
Large and medium sizes (the Nos. I and II qualities of Indian trade).	$36 (Rs. 60-5-0)	= Rs. 1,013-4-0 (= £67½).
Small size (the No. III quality of Indian trade).	$28 (Rs. 46-14-5)	= Rs. 817-15-0 (= £54½).

Smoked :—

Mixed sizes	$30 (Rs. 50-4-0)	= Rs. 844-6-0 (= £56½).

NOTE.—Exchange was at Rs. 167½ to $100 and the picul is taken as 133⅓ lb.

Fourteen years ago Saville-Kent quoted the following rates as then ruling for the principal kinds exported from Australia and these may be usefully quoted here for comparison and reference.

Local name (Australia).	Value per ton.
Teat-fish, black and ordinary	£140 to £150
Do. White	40
Red-fish, ordinary and deep-water	100 to 110
Do. surf	80 to 90
Black-fish, deep-water	100
Do. ordinary and Caledonian ...	80 to 90
Large Lolly-fish	35
Prickly-fish or prickly-red	30 to 40
Sand-fish	20 to 30

It is most significant to note that the species with which we dealt last year and which sold at Rs. 1,013-4-0 and Rs. 817-15-0 (£67½ to £54½) per ton for large and small sizes respectively is

quoted in the above table (" Sand-fish ") at the much lower figures of £30 to £20 per ton, a difference due apparently to the more satisfactory treatment of the same class of raw material evolved in India.

As indicating the considerable importance of this industry on the Australian coast, we may note that the annual exports from Queensland, including re-exports of New Guinea produce between the years 1880 and 1889 (the only years for which I have statistics) ranged between 3,757 cwt., valued at £14,529 and 6,841 cwt., valued at £31,581 ; practically all of this went direct to China. For much of the material collected in Borneo and the Dutch Indies, Singapore is the clearing-house ; in 1915, the imports of bêche-de-mer amounted to the exceptionally large quantity of 9,379 cwt., valued at $215,061. Practically all of this was re-exported to China.

From these figures it will be seen that the Indian and Ceylon production is at present a negligible proportion of the total consumption and that we need have no fear of ever experiencing any difficulties in disposing of our production, however greatly we may expand the industry.

As I believe the trade ramifications of this industry are very little known, I append (Tables I, II, III and IV) tabulated statistics of the imports into and exports from Penang and Singapore, of bêche-de-mer, for the past ten years. From these, several interesting facts emerge. We see that Borneo and the Philippines between them produce nearly 50 per cent of the total imports into Singapore on an average of ten years, while in some seasons fully three-fourths of the total comes from these islands. South Africa is a late comer into the trade, her exports beginning in 1915. The large imports into Singapore from Hongkong and China in some years are puzzling and seem larger than local consumption can require. It is to be noted that Ceylon produce goes almost entirely to Penang for sale and that no exports to that port have taken place since 1914, a fact largely due, I believe, to deterioration in methods. (Information recently received shows that the methods pursued by some important curers in Ceylon are even worse than those formerly practised in India—the material is sometimes boiled once only, the limy coating imperfectly removed and the material dried on the sand without mats.)

The variations in the values placed by the Ceylon exporters upon their produce are remarkable and appear to indicate that the rates given bear in some years little or no relation to the real market value of the produce.

The tables given are compiled from statistics kindly supplied by the Registrars of Imports and Exports of Singapore and Penang to whom I am greatly indebted for this courtesy.

THE PROSPECTS OF THE INDUSTRY IN INDIA.

We have already seen that the Chinese market will absorb all we can possibly produce, and that the only limitations are those of the natural supply in our littoral waters.

I have not as yet been able to examine that part of the northern half of Palk Bay and Strait which from its depth and probable faunistic conditions is likely to be productive of the only valuable species at present available, but so far as the southern half is concerned I have located the chief beds. These lie principally in the south-west angle, where large areas of sandy bottom are found, extending from Tirupalakudi in the north to Pillaimadam and Mandapam in the south-east. This appears to be the richest ground as on several occasions over 10,000 of these animals have been collected in a single day by a small diving force varying between 23 and 31 men.

Another centre is Pamban where a good deal of white attai is obtained by diving and by wading over the sand-flats at low tide. Rameswaram Bay has also yielded sufficient to keep a small factory busy in former years but at present the divers report a scarcity of material there. White attai is also met with, but generally in small quantities, in depths of 1 to 3 fathoms in the inner passage between the mainland and the Ramnad and Tinnevelly Islands as far south as Tuticorin.

At present the Government factory at Tirupalakudi is the only one in operation. The small private concern at Pamban closed down last year, and this locality may be worth attention when the Krusadai Island Station be built, as a curing station could then be supervised with a minimum of trouble and expense. In the meanwhile the most likely situation for a second station is Vedalai, where is located a small community of divers already working in the Government Chank Fishery. It has to be borne in mind that under present conditions the bêche-de-mer fishery is not sufficiently

remunerative to induce divers to devote their whole time to it; it has to be worked as an auxiliary to the chank fishery, and as already explained the conjunction is a welcome one to the divers.

Any large increase in the industry in any locality where the animals are fairly abundant, will depend chiefly upon whether any substantial increase in the rates paid, can be given. Last year very low rates prevailed as the cost of preparation had to be ascertained, and the general impression among the coast people was that the market was abnormally low. Accordingly the divers agreed to meet Government in this situation by accepting considerably lower rates than prevailed when the trade was flourishing. The prices agreed upon were Rs. 10-6-8 per 1,000 for No. I quality, Rs. 5-3-4 per 1,000 for No. II and Rs. 1-11-9 for No. III.

With the favourable experience of last year as a guide and according to my promise to the divers, the rates fixed for this year's transactions have been increased to Rs. 6-8-2 in the case of the larger grades (Nos. I and II which are now to be treated as a single grade), and to Rs. 2-9-8 per 1,000 in that of the smaller size (No. III) to which it is necessary to give special encouragement. If the results of the present season's work again show a large margin of net profit, it will be necessary to consider what further increase can be given in the following year, as every enhancement of the rate will make the divers more willing to devote increased attention to this section of their work, and with larger catches, the cost of curing, etc., will be reduced and the turn-over much augmented. It will also tend to attract a larger number of divers and this will not only benefit the bêche-de-mer fishery but will prove of much value in assisting recruitment for the chank fishery.

Black attai *(Holothuria atra)* is exceedingly abundant and although it is reputed to have been used occasionally to adulterate and colour parcels of white attai, it does not appear to have been fished specifically for its own sake.

Accordingly I instituted a number of experiments and found that while there is no difficulty in curing this species, the weight of the dried product is so insignificant (approximately half that of average No. III grade of white attai) and its quality is considered so poor by the Chinese, that the price quoted in Singapore for the sample sent, about Rs. 7 per picul, makes it impossible to cure this species at a profit.

In regard to white attai, evisceration prior to boiling while desirable is not absolutely necessary; in the case of the black kind it is essential because whereas the former eviscerate through the vent during the boiling process, the black ones if not eviscerated by slitting open, burst irregularly midway along their length, eviscerate through this opening and end by drying in contorted and ugly shapes. If slit open for a short distance from the posterior end, the viscera come out freely and when subsequently boiled the animal does not contort, but remains straight and natural looking.

The only localities on the mainland of India where commercial kinds of bêche-de-mer are available or can be fished are Palk Bay and the south Ramnad coast. On the Malabar coast the bottom is too muddy, while on the Coromandel coast the absence of a diving element in the fisher population would prohibit it, even were bêche-de-mer to occur in quantity there, a point not at present ascertained.

But if the prolific mainland area be restricted, there is considerable prospect of the insular region of the Laccadives proving worth attention and exploitation. When I was at Kiltan atoll in 1908, I found the islanders preparing small quantities and judging from this fact and by analogy in regard to the faunistic character of the great reef-flats of Bitra, Cherbaniani, Perumal and Byramgore with Polynesian reefs where bêche-de-mer is very abundant, it is desirable that Government should take an early opporunity of having this region explored thoroughly by officers of the Fisheries Department with a view to test the potentialities of this archipelago in regard not only to general fishing development and to this product in particular, but also in respect of mother-of-pearl-producing shells as green snail (*Turbo*), trocas (*Trochus*), and even the true pearl-oysters (*Margaritifera* spp.).

As the method employed in the Laccadives is different from that followed in Palk Bay and Ceylon, it will be useful to put the particulars on record of what I learnt during my visit to the islands in 1908. So far as I could learn the industry had then but recently been introduced. I was informed indeed that it had been brought to the attention of the islanders only three years before by a Cannanore Mappilla who stayed in the island for some time supervising the collection and curing of the product. As taught by this man the process is carried on as follows.

Each holothurian is first slit open longitudinally and the viscera removed; the thick fleshy body-wall remaining is washed in sea water and then boiled for about half an hour. As in the Palk Bay curing operations, the time when the material should be removed from the cauldron is judged by the odour given out. After removal from the boiler the pieces are pinned open by the insertion of short wooden skewers in order to prevent curling, and are then exposed for drying to the full glare of the sun upon a cadjan platform raised 2½ feet from the ground. When dried thoroughly they are stored till enough be accumulated to send to Mangalore. The price received from the middlemen of the latter port was reported to be from Rs. 3 to Rs. 5 per tolam of 28 lb., equivalent to Rs. 240 to Rs. 400 per ton, far too low a price if the quality of the product approaches that produced by like-circumstanced coral atolls in the Pacific, as I have little doubt is the case.

The species of bêche-de-mer available in quantity at Kiltan are three:—(*a*) *Vella kōkā*, mottled grey and dirty brown, (*b*) *Karrta kōkā*, black in colour, and (*c*) *Soganna kōkā*, of reddish-brown hue. The animals are collected by wading in the lagoon and on the reef-flat at low tide and also by spearing from boats.

At Androth, I noticed abundance of large holothurians in the shallows, but here no curing is carried on, as the elders of this particular island are strongly opposed to any development of such an industry from religious or rather from superstitious reasons. A venerated mullah now deceased had fulminated against any traffic in such scaleless inhabitants of the sea, and had banned with threat of misfortune any who should take it up, a prophecy which, I was told, duly came true in several instances. Hence although the people admit that the trade can be made to give a good return they will have nothing to do with it. This attitude need not hamper any prospective attempt to develop a large trade in the islands, as it is only the inhabitants of Androth who take up this attitude.

If steps be taken to extend the bêche-de-mer trade in the Laccadives, the result should be of considerable benefit to the islanders, for at present the industry is so restricted as to be of no commercial importance—the main sources of supply being untapped—while the prices obtained appear to be inadequate, the islanders being entirely at the mercy of the middlemen, who impose any rate they like to fix, trading as they do upon the islanders' ignorance of the true market value of the product.

SUMMARIZED RECAPITULATION.

The bêche-de-mer industry in India depends upon a single species, *Holothuria scabra*, called *vellai attai* (white leech) in Tamil. Two other species are abundant, the black and the prickly-green (*H. atra* and *Stichopus chloronotus*). The former is common on coral-reef flats, but has little commercial value as it shrinks to very small size and has little weight—less than half the weight of the poorest quality of *vellai attai*—when cured. The prickly-green species is too gelatinous to cure; and is found in fair quantities in Rameswaram Bay only.

The " white-fish " as we may call *H. scabra*, is akin to the " sand-fish " of Australian trade, where it is held in low esteem (Rs. 300 to Rs. 450 per ton) owing to the presence of a thick chalky coat on the exterior. In India this coating is removed by an ingenious and simple device and in consequence the product has ready sale and fetches good prices when well cured. No endeavour is made to remove the chalky layer in Australia and the Malay Archipelago, hence the introduction there of the Indian method should be of considerable benefit to the trade.

This industry in India is probably of considerable antiquity, introduced, improved, and periodically revived by immigrant Chinese curers.

The Chinese were careful and conscientious workers; they produced an excellent product and were prosperous till local men, chiefly Kilakarai Labbais, ousted them by boycott. The local curers invariably allowed their methods to deteriorate after a few years, with the result that the market value of the produce became unremunerative and the trade lanquished and died out until again revived by the advent of another Chinese curer who reorganized methods and re-established the reputation of the Indian product.

The Customs statistics show that in the twelve years from 1898 to 1910 the average annual export of bêche-de-mer was 12,175 lb.; during the ensuing six years the annual export fell to an average of 2,991 lb. only. In 1915 the industry had virtually died out. The trade was in one of its periodical collapses in 1914–15 when first investigated.

Many abuses were found to have crept into the curing methods, the chief being (*a*) faulty evisceration, (*b*) imperfect removal of the chalky external coat, (*c*) careless and dirty sun-drying, (*d*) imperfect

sterilization by smoking, (*e*) too prolonged storage, (*f*) trickery in mixing inferior stuff with good.

To attempt a revival of the industry and thereby to increase the earnings of the local chank divers, the Madras Government in G.O. No. 2739, Revenue, dated 9th December 1915, authorized the establishment of a bêche-de-mer curing station at Tirupalakudi on the south-west coast of Palk Bay. Work was commenced in August 1916 and the first parcel of cured material was shipped to Singapore in the following December. The quality was found so satisfactory that it sold at the following high rates :—

Unsmoked :—

	RS.	A.	P.	
Large and medium sizes ...	1,013	4	0	(£67½) per ton.
Small size	817	15	0	(£54½) ,,

Smoked :—

Mixed sizes	844	6	0	(£56) ,,

After allowing for depreciation of buildings and plant, together with supervision charges, the net profit on the first half season's work was equal to over 63% upon the expenditure, a rate which has justified a substantial increase in the rates now being paid to the fishermen. The curing methods at present in operation are as follows :—

(*a*) Thorough evisceration before or during boiling.

(*b*) Boiling without the addition of water till the animals shrink to half their length and emit a distinctive odour (40 to 50 minutes from time of applying heat to the pans).

(*c*) Burial under damp sand for 12 to 18 hours.

(*d*) Removal of the chalky external coat, first by hand manipulation and then by foot trampling in a basket.

(*e*) A second boiling for 20 minutes; this time sea water sufficient to cover is added.

(*f*) Either full drying upon wire-net trays raised above the ground or half sun drying and then finishing off in a smoke-house. In the latter case the product should become very dark red in colour.

Constant care has to be maintained to keep the material thoroughly dry during storage by means of occasional re-exposure to sunshine.

The best markets for Indian produce are Singapore and Penang, shipment being made by mail steamer from Negapatam. No

shipment should be made during the rainy season, lest the material get wet or damp on the journey.

Unsmoked sun-dried bêche-de-mer is preferred for local consumption in the Straits Settlements; for re-export to China, the better keeping smoke cure is required.

The only commercially workable areas producing bêche-de-mer off the Indian mainland appear to be the south-west angle of Palk Bay, the Pamban Pass neighbourhood and Rameswaram Bay. It is contemplated to open new curing stations as circumstances justify at Vedalai (near Mandapam), at Krusadai Island (Pamban), and possibly at Rameswaram.

The Laccadive Islands urgently require investigation as to their bêche-de-mer producing resources. Great reef-flats exist there which by analogy, faunistic and physical, with other reef areas in the Pacific, appear very promising. In 1908 the writer saw a small quantity of bêche-de-mer being dried in the island of Kiltan. Three species of commercial value were observed. The methods of cure adopted were different from those practised in Palk Bay; they approximated closely to those of Australia and Polynesia.

TUTICORIN,
28*th June* 1917. JAMES HORNELL.

TABLE I.—Imports of Bêche-de-mer into Singapore for the years 1907 to 1916.

	1907.		1908.		1909.		1910.		1911.		1912.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	PICULS.	$	PICULS.	$	PICULS.	$	PICULS.	$	PICULS.	$	PICULS.	$
Aden	72	1,070	176	1,008	22	162	...	...	30	300	280	2,200
Mauritius	82	1,850	141	2,364	180	2,800	143	2,370	154	4,268	43	861
Union of South Africa ...	...	...	...		...	...	...	...	...	...	...	...
Bombay	...	...	47	614	...	..	...	...	...	...	..	...
Calcutta	...		...	...	...	...	...		...	...	72	1,072
Burma	50	1,700	71	1,720	...	...	...	...	...	...	2	140
Madras	40	560	80	1,086	...	...	...	..	...	...	...	...
Ceylon	...	...	...	...	..		31	630	...	...	...	...
Tringganu	9	450	2	40	...	...	...		1	20	1	19
British North Borneo ...	960	32,478	418	13,042	564	15,789	365	9,286	907	28,384	680	24,216
Hongkong	312	10,932	737	11,955	277	6,528	30	600	25	570	20	230
Australia	940	19,411	111	3,412	3	126	58	1,318	4	80	28	560
Straits ports	177	6,223	296	6,865	107	1,887	59	1,377	...	...	47	1,530
Other British possessions...	40	810	...	...	...	...	...	...		...	...	...
France	200	1,600	30	300	...	...	...	.	...	...	...	...
Egypt	75	1,475	...	...	...	...	...	...	...	...	...	..
Sumatra	284	12,136	178	6,568	228	5,930	238	9,531	374	12,463	184	7,241
Java	154	4,130	141	4,406	53	1,345	38	735	54	1,530	48	2,195
Celebes	1,682	44,818	547	21,830	700	23,805	582	14,883	653	19,997	749	24,629
Moluccas	...	..	33	1,000	42	1,320	168	5,339	154	2,462	184	4,108
Natunas and Anambas Islands.	13	360	18	415	7	235	9	250	82	2,973	25	560
Dutch Borneo	357	7,967	164	3,017	529	11,484	1,118	23,879	777	17,923	376	9,808
Bali and Lombok	123	3,661	55	1,165	17	310	6	183	196	4,094	193	4,985
Other Dutch Islands ...	870	37,627	1,203	58,535	476	21,045	550	18,216	261	13,703	321	14,178
Philippines and Sulu Archipelago.	1,077	21,975	656	12,075	903	14,764	980	16,739	1,774	31,425	1,421	29,097
Siam	...	...	...	.	...	...	2	44	3	72	..	...
French Indo-China ...	...	...	...	...	...	...	4	80	29	737	26	451
German New Guinea ...	31	465	95	706	30	700	24	520	87	1,720	...	...
China	...	...	...	...	26	1,140	13	220	...	...	8	334
Japan	3		..	..	1	80	5	290	1	100	5	333
Other Foreign Countries ...	...	..	45	320	246	8,240	170	8,500	...	...	24	900
Total ...	7,551	211,994	5,244	152,443	4,411	117,690	4,593	114,990	5,566	142,821	4,737	129,647

Values in Straits dollars.

TABLE I.—Imports of Bêche-de-mer into Singapore for the years 1907 to 1916—*cont.*

	1913.		1914.		1915.		1916.		Annual average.		Average rate per picul in $.	Average rate per picul in rupees, etc. 1 $ = Rs. 1-12-0.
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.		
	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)
	Piculs.	$	Piculs.	$	Piculs.	$	Piculs.	$	Piculs.	$		Rs. A. P.
Aden	1,590	11,866	138	1,300	...	...	...	...	230·8	1,790·6	7·7	13 7 7
Mauritius	54	650	140	2,512	245	4,125	218	3,055	140·0	2,485·5	17·7	30 15 7
Union of South Africa	...	...	...	...	669	11,035	140	2,820	404·5	6,927·5	17·1	29 14 9
Bombay	200	1,600	...	...					(Over 2 years.)			
Calcutta	...	...	...	...								
Burma	...	...	...	...	182	3,640	...	...	74·4	1,213·2	16·3	28 8 4
Madras	..		...	.								
Ceylon	...	...	...	...	...	...	...	...	3·1	63·0	20·3	35 8 4
Tringganu	1	26	10	237	...	...	4	200	2·8	99·2	35·4	61 15 2
British North Borneo ...	567	22,269	515	18,527	963	31,595	875	34,942	681·4	23,052·8	33·8	59 2 4
Hongkong	116	2,655	58	1,200	...	...	97	3,280	167·2	3,795·0	22·6	39 8 9
Australia	60	973	37	814	...	...	109	5,755	135·0	3,244·9	24·0	42 0 0
Straits ports	105	3,375	197	6,265	196	6,385	113	3,325	129·7	3,723·2	28·7	50 3 7
Other British possessions...	...	...	15	324	288	3,601	...	...	34·3	473·5	13·8	24 2 4
France	...		..	..	...	...	. .	...	23·0	190·0	8·2	14 5 7
Egypt	...	...	6	50	..	...	...	...	8·1	152·5	18·8	32 14 4
Sumatra	286	12,574	216	11,169	279	11,141	301	10,958	256·8	9,971·1	38·8	67 14 4
Java	16	510	31	1,201	.	...	40	1,406	57·5	1,745·8	30·3	53 0 4
Celebes	569	20,656	166	7,584			122	5,805				
Moluccas	122	5,220	147	6,461	320	14,741	393	16,401	733·3	24,105·9	32·8	57 6 4
Natunas and Anambas Islands.	62	2,410	20	770	...	...	160	4,531	39·6	1,250·4	31·5	55 2 0
Dutch Borneo	435	8,746	419	8,907	828	16,590	1,961	37,532	696·4	14,585·3	20·9	36 9 2
Bali and Lombok	72	1,965	34	785	95	2,541	81	2,650	87·2	2,233·9	25·6	44 12 9
Other Dutch Islands ...	374	15,626	265	12,610	659	25,232	368	15,175	534·7	23,194·7	43·3	75 12 4
Philippines and Sulu Archipelago.	1,494	33,107	2,238	46,592	4,651	84,265	1,567	29,484	1,676·1	31,952·3	19·0	33 4 0
Siam	...	...	35	605	...	...	...	...	4·0	72·1	18·0	31 8 0
French Indo-China ...	34	549	18	288	...	...	22	330	13·3	243·5	18·3	32 0 4
German New Guinea ...	...	...	85	1,200	...	...	...	..	44·0	663·8	15·0	26 4 0
									(Over 8 years.)			
China	...	...	31	765	...	...	4	320	8·2	277·9	33·8	59 2 4
Japan	14	712	3	120	...	..	13	1,150	4·5	308·1	68·4	119 11 2
Other Foreign Countries ...	...	...	15	1,050	4	170	..	...	50·4	1,918·0	38·0	66 8 0
Total ...	6,171	145,489	4,839	131,336	9,379	215,061	6,588	179,119	5,907·9	154,059·0	26·0	45 8 0

TABLE II.—Imports of Bêche-de-mer into Penang for the years 1907 to 1916.

(1)	1907.		1908.		1909.		1910.		1911.		1912.	
	Quantities. (2)	Values. (3)	Quantities. (4)	Values. (5)	Quantities. (6)	Values. (7)	Quantities. (8)	Values. (9)	Quantities. (10)	Values. (11)	Quantities. (12)	Values. (13)
	PICULS.	$	PICULS.	$	PICULS.	$	PICULS.	$	PICULS.	$	PICULS.	$
Aden	...	...	46	800	356	3,587	...	...	..	...	...	...
India	50	800	...	...	...	...	...	...	50	840	...	..
Burma	143	4,724	172	6,217	107	4,356	216	10,489	238	14,662	69	3,363
Ceylon	218	9,300	450	10,500	115	2,760	58	550	..	...	170	2,250
Hongkong ...	19	1,500	26	2,373	27	2,109	72	4,221	41	4,305	17	2,120
Australia ...	...	...	...	...	...	...	...	...	..	...	...	...
Kedah	...	...	..	...	...	...	...	...	17	1,030	...	...
Straits ports ...	...	...	296	6,865	41	1,659	30	1,785	159	6,648	336	16,243
Other British possessions.	...	...	...	...	...	...	...	...	...	..	...	...
Sumatra	31	857	13	351	3	85	17	567	63	1,893	63	2,751
Dutch Islands ...	...	...	...	...	...	...	...	...	...	...	...	...
Siam (West Coast).	106	3,281	128	5,139	46	2,341	27	1,547	135	7,750	109	5,632
Japan	...	...	...	...	9	740	...	...	2½	190	6	410
Other Foreign Countries.	...	...	...	...	...	...	...	...	...	...	...	...
Total ...	567	20,462	1,131	32,245	704	17,637	420	19,159	705½	37,318	770	32,769

TABLE II.—Imports of Bêche-de-mer into Penang for the years 1907 to 1916—*cont.*

	1913.		1914.		1915.		1916.		Annual average.		Average rate per picul in $.	Average rate per picul in rupees, etc. 1 $ = Rs. 1-12-0.		
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.				
	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)		
	PICULS.	$	PICULS.	$	PICULS.	$	PICULS.	$	PICULS.	$		RS.	A.	P.
Aden	...	...	...	...	...	...	...		40·2	438·7	10·9	19	1	2
India	339	6,680	247	7,780	439	13,076	743	25,741	312·1	10,709·0	34·3	60	0	4
Burma	148	4,880	160	3,482										
Ceylon	156	6,249	...	...	...	...	.	...	116·7	3,160·9	27·0	47	4	0
Hongkong ...	29	2,769	23	2,183	27	2,344	76	4,652	35·7	2,857·6	80·0	140	0	0
Australia ...	...	...	...		173	3,914	..	...	17·3	391·4	22·6	39	8	9
Kedah	4	100	...	...	..	...	. .	...	2·1	113·0	53·8	94	2	4
Straits ports	204	6,808	104	3,023	62	1,533	67	1,855	129·9	4,641·9	35·7	62	7	7
Other British possessions.	...	...	...	...	...	...	9	177	·9	17·7	19·6	34	4	9
Sumatra	41	2,382	55	2,628	..	...	220	5,871	50·6	1,738·5	34·3	60	0	4
Dutch Islands ...	...	...	...	...	23	733	...		2·3	73·3	31·8	55	10	4
Siam (West Coast).	105	3,276	14	256	61	2,021	143	3,466	87·4	3,470·9	39·7	69	7	7
Japan	...	...	4	340	...	...	.	...	2·15	168·0	80·0	140	0	0
Other Foreign Countries.	...	...	..	...	9	175	8	484	1·7	65·9	38·7	67	11	7
Total ...	1,026	33,144	607	19,692	794	23,796	1,266	42,246	799·05	27,846·8	34·8	60	14	4

TABLE III.—Exports of Bêche-de-mer from Singapore for the years 1907 to 1916.

	1907.		1908.		1909.		1910.		1911.		1912.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	PICULS.	$	PICULS.	$	PICULS.	$	PICULS.	$	PICULS.	$	PICULS.	$
Burma	...	...	...	...	...	...	...	...	5½	330	7	361
Perak	...	...	...	...	4	138	...	..	2	40	4	130
Selangor ...	11	88	28	956	26	606	6	134	40	658	36	558
Sarawak ...	...	...	⅕	15	8	600	2	140	3	190	...	..
Hongkong ...	7,214	315,882	5,016	201,161	2,564	76,182	2,553	77,996	2,559	80,151	2,865	102,217
Straits ports	92	991	9½	337	...	...	18	740	162	2,654	178	1,720
Other British possessions.	...	...	4	101	...	...	¼	16	...	...	...	...
Sumatra ...	1	40	..	...	2	129	1	80	1	30		...
Java	5	288	2½	70	1	20	1	35	2	105	...	...
Dutch Borneo ...	...	...	...	..	1	20	1	65	..	..	...	...
Other Dutch Islands.	...	...	17	850	...	...	3	120	...	...	...	...
Siam	2	120	5	290	...	...	2	120	14	880	2	80
China	2,764	124,693	2,461	109,729	2,220	76,655	2,384	80,997	2,586	87,332	2,544	81,740
Other Foreign Countries.	...	...	...	...	...	...	...	...	..	...	...	...
Total .	10,089	442,102	7,543·2	313,509	4,826	154,350	4,971·25	160,443	5,374·5	172,370	5,636	186,806

TABLE III.—Exports of Bêche-de-mer from Singapore for the years 1907 to 1916—*cont.*

	1913.		1914.		1915.		1916.		Annual average.		Average rate per picul in $.	Average rate per picul in rupees, etc. 1 $ = Rs. 1-12-0.
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.		
	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)
	PICULS.	$	PICULS.	$	PICULS.	$	PICULS.	$	PICULS.	$		RS. A. P.
Burma	...	...	2	140	...		2	200	1·65	103·1	62·4	109 3 2
Perak	10	146	2	64	...	...	1	20	2·3	53·8	23·3	40 12 4
Selangor ...	14	216	8	80	...	...	3	100	17·2	339·6	19·7	34 7 7
Sarawak ...	...	...	6	220	...	...	3	87	2·22	125·2	56·3	98 8 4
Hongkong ...	1,900	61,200	1,586	56,120	3,521	119,881	2,232	77,547	3,201·	116,833 7	36·4	63 11 2
Straits ports ...	119	1,324	179	2,671	62	1,533	67	1,865	88·65	1,383·5	15·6	27 4 9
Other British possessions.	2	172	...	...	2	150	6	236	1·4	65·9	47·	82 4 0
Sumatra ...	5	145	4	71	...	...	...	...	1·4	49·5	35·3	61 12 4
Java	...	...	76	1,110	...	...	...	...	8·75	162·8	18·6	32 8 9
Dutch Borneo ...	5	150	...	...	...	...	...	...	·7	23·5	33·5	58 10 0
Other Dutch Islands.	..	...	...	...	...	...	...	...	2·	97·	48·5	84 14 0
Siam	...	...	10	310	...	...	5	380	4·	218·	54·5	95 6 0
China	2,538	91,552	2,583	116,525	5,979	159,896	3,205	156,868	2,926·4	108,598·7	37·1	64 14 9
Other Foreign Countries.	...	...	...	...	3	180	...	...	·3	18·	60·	105 0 0
Total ...	4,593	154,905	4,456	177,311	9,567	281,640	5,524	237,303	6,257·995	228,073·9	36·4	63 11 2

TABLE IV.—Exports of Bêche-de-mer from Penang for the years 1907 to 1916.

	1907.		1908.		1909.		1910.		1911.		1912.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	PICULS.	$	PICULS.	$	PICULS.	$	PICULS.	$	PICULS.	$	PICULS.	$
India ...	...	...	...	...	..	...	8	410	..	...	...	...
Burma	7	700	19	1,800	9	673	4	230	16	1,030	24	877
Hongkong ...	591	21,909	1,620	48,485	1,764	54,020	632	20,350	430	16,330	582	21,650
Federated Malay States.	...	...	...	...	19	892	10	369	16	1,198	10	564
Straits ports ...	3	60	159	5,906	292	12,885	253	13,839	455	22,756	45	2,254
Other British possessions.	...	...	...	...	...	...	1	30	..	...	...	...
Sumatra	...	...	2	130	5	215	11	692	...	...	2	165
Siam (West Coast).	2	86	...	...	...	...	...	...	...	...	...	...
China	1	40	...	.	131	6,498	...	...	...	...	...	...
Total ...	604	22,795	1,800	56,321	2,220	75,183	919	35,920	917	41,314	663	25,510

TABLE IV.—Exports of Bêche-de-mer from Penang for the years 1907 to 1916—*cont.*

—	1913.		1914.		1915.		1916.		Annual average.		Average rate per picul in $.	Average rate per picul in rupees, etc. 1 $ = Rs. 1-12-0.
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.		
	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)
	PICULS.	$	PICULS.	$	PICULS.	$	PICULS.	$	PICULS.	$		RS. A. P.
India	...	...	..	...	...	...	...	...	·8	41·0	51·2	89 9 7
Burma	20	572	19	342	...	...	...	...	11·8	622·4	52·7	92 3 7
Hongkong ...	695	23,519	205	9,000	456	14,245	641	25,840	761·6	25,534·8	33·5	58 10 0
Federated Malay States.	...	...	...	...	...	...	...	...	5·5	302·3	54·9	96 1 2
Straits ports ...	116	4,961	145	3,475	256	7,103	110	3,205	183·4	7,644·4	41·6	72 12 9
Other British possessions.	2	150	...	...	10	672	13	380	2·6	123·2	47·3	82 12 4
Sumatra	2	79	2	102	..	...	...	.	2·4	138·3	57·6	100 12 9
Siam (West Coast).	1	50	...	...	...	...	...	...	·3	13·6	45·3	79 4 4
China	6	180	...	...	...	...	...	...	13·8	671·8	48·6	85 0 9
Total ...	842	29,511	371	12,919	722	22,020	764	29,425	982·2	35,091·8	35·7	62 7 7

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MADRAS FISHERIES DEPARTMENT.

CARP-GROWING IN GERMANY

BY

SIR F. A. NICHOLSON,

Honorary Director of Fisheries, Madras.

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CARP-GROWING IN GERMANY.

BY

SIR F. A. NICHOLSON,
HONORARY DIRECTOR OF FISHERIES, MADRAS.

The paper printed below was contributed in 1908 to the *Madras Mail* and is now republished by kind permission. It should have found place in bulletin No. I but was accidentally omitted.

Its origin accounts for the merely popular form in which it is written, but it appears to embody useful facts and suggestions. The intelligent industry of the ordinary German peasantry yields a remarkable lesson for our own folk, but the methods are not confined to Germany or even to Europe, but are very highly developed in China and Japan.

While carp have been solely dealt with in this paper, it should be noted that better fish, yielding as good results in weight and better results as food, will shortly be available; this Department has, since the paper was written, introduced tench and gourámi (*Osphromenus olfax*) to our low-country waters, and when these have sufficiently increased they may be issued for private culture.

The curing yards will also probably be able to supply cheap food for artificial feeding, since there is considerable refuse from all classes of fish-curing, whilst masses of manurial fish (sardines and "podimin") caught in excess can frequently be dried, ground up, and sold at extremely low rates. But in most cases the local sources of refuse and wild foods, as additions to those found in the ponds themselves, must be relied on for the artificial feeding of fish.

Some of the most pleasant days of a recent tour in Europe were spent in visiting peasant holdings in Bavaria where the farmers grow crops of cereals and of fish, mostly carp, alongside of one another. There are many thousands of these carp ponds in this small kingdom and, as one farmer said, they are more profitable than an equal area of good land. The ponds visited which are typical, are purely natural drainage ponds lying in low bottoms

and fed by the melting of the snow, etc., and by the drainage from the fields. They lie nearly empty throughout the winter, so as to kill off noxious animal life and useless vegetation. Once in every ten years or oftener, the ponds are kept dry throughout the summer, and cultivated with cereals (oats), which then produce a heavy crop. This process sweetens the pond beds and destroys noxious growths. It is usual to dig out during winter a quantity of the pond mud, and this mixed with lime, is an admirable manure for the arable land. The pond vegetation is, in general, natural, such as "water roses" (lotuses and lilies), *Vallisneria*, *Festuca fluitans* (water rice), various sedges, etc. Shade in Germany is not generally desirable, for the one aim of the carp grower is to get and keep the water as warm as possible during the summer. A very few degrees of heat make a vast difference in the crop. Yet in parts of Germany, as in France, it is found necessary to temper the extreme heat which in shallow ponds sometimes raises the water almost to blood heat, by properly selected and encouraged vegetation. This not only shelters the fish but oxygenates and purifies the water and the bed. In India owing to the great heat, external shade would probably be desirable while the droppings from the marginal trees would provide useful food. The first farm visited comprised an area of about 180 acres, of which half was shallow water, half somewhat poor light sand. The homestead contained a neat house and excellent farm buildings (everywhere in Germany one is struck with the completeness of the latter), while the cow stable had about a score of cows in splendid condition, as clean as washing could make them, and floors of wood lightly covered with litter and sloping gently to a central drain. The litter is daily removed with solid excreta to the manure pit and fresh litter is put in; most of the fluids, however, are intentionally drawn off by a central drain through a pipe direct to the main pond of about 50 or 60 acres, in order to assist in the growth of fish food. The merit of these Bavarian carp growers is that they utilize land habitually covered by water in the bottom of valleys too wet for ordinary cereal growth, and that they assist the growth of the fish by manuring the water, just as they would manure the land, and occasionally by giving small quantities of boiled or raw cereal food or domestic refuse. The ponds are in general surrounded by and receive the drainage from the cultivated lands, which whether pasture or arable, are all manured; hence a considerable quantity of the manure is used indirectly by the fish and not by the grass or cereal crops. All

agree that the droppings of cattle are among the best foods for carp, not in general directly but because they promote small life abundantly, both animal and vegetable, and on these the carp feed. On testing such ponds with a dipper it was found that the water, especially at the margin and near the inlet from the farm-stead, was fairly alive with "water fleas" and various animalculae, while the water of unmanured ponds was far less prolific.

Taking this and other farms together, the general practice is that in April and May a few reproductors, usually one female to 2, 3 or 4 males, are placed in special small breeding ponds in which branches, especially those of juniper, or other simple arrangements for the attachment of the adhesive eggs, are placed. These can either be removed at once with the adherent eggs or allowed to remain till the eggs hatch. The arrangement is similar to that in Japan as described in a note on Japanese Fisheries. If the pond owner has no spawners he can either buy them for spawning in his pond, or he can buy the ova, or fry ready hatched. There is a regular trade with carefully designed casks or vessels for the transport of spawners, ova, or fry. When the fry are about a fortnight old the breeding ponds are slowly drained, fine meshed baskets or nets in which the fry are caught being placed at the outlet; these are then transferred to the main ponds. In more scientific arrangements small rectangular ponds have nicely figured beds sloping to a central ditch from which it is easy to net out the small fry so that they are not crushed in the basket by the rush of the water. The removal of the fry is necessary in order both to prevent the parent carp from devouring them and to give them room and food to develop. By November they have reached the fingerling stage, weighing one or two ounces and are then retained in deep wintering ponds. At the end of the next summer, they may be 1 lb. or more and at the end of the third summer, 2½ to 3 lb. They are usually sold at this age as the larger and older ones are coarse; spawners (females) are kept up to 10 years, but are then worth less than half-price as food. A little cereal food such as maize, boiled or raw, is sometimes given if available, or any house refuse, etc., carp being omnivorous; lupin seed or cake is a favourite food of carp and is not only cheap but contains about one-third of albuminoids. But in the Bavarian ponds food is not in general given to any great extent, the owners relying chiefly on the natural or acquired resources of the ponds. It will be observed that the main ponds contain, in each year, a number of first, second, and third year fish

of which the first have been newly hatched in separate ponds while the others have been retained from previous years, hibernating during the winter. In November of each year the ponds are almost entirely drained and the pools are then netted for their contents ; the marketable ones are culled out and sold to contractors from the cities and towns, while the others are returned to the pools for the winter ; those purchased for consumption are stored by the contractors in reservoirs or special pools till needed ; and since carp hibernate they need no food, and practically lose no weight, while in storage.

The price at present is comparatively low, viz., a little over 7½ annas per pound. The produce per acre is smaller than I expected, though the owners do not seem dissatisfied. My chief informant wished that all his land were water as giving more profit and less trouble than arable land. His live weight produce on 88 acres averages 100 German centners or 11,000 lb. English or 125 lb., worth Rs. 60 per acre, which is slightly better than the general Bavarian average of 110 lb. per acre. On another set of ponds the outturn of 200 acres was 22,000 lb. worth 14,000 marks, of which 4,000 are allowed for cultivation expenses ; net profit 10,000 marks, or 50 marks (Rs. 37-8-0) per acre, but from this must be deducted an allowance for bad years (owing to drought, floods, disease, etc.) and so forth. Still the average net profit is obtained with some certainty and a minimum of trouble. In India it is believed, as will hereafter be shown, that the outturn per acre of available water may be far greater.

In another part of Germany a visit was paid to a leading carp and trout culturist, who courteously showed not only his own establishment but a large experiment now in progress for utilizing a large area of waste and barren heath land of no present value for cereal crops ; a similar and successful experiment was seen in Belgium. This low lying marshy land has been fashioned into ponds fed from a navigation canal which borders them ; the system is similar to that known as Dubisch's system, the spawning taking place in very small breeding ponds whence, after a few days, the fry are collected and placed in larger ponds (nurseries) and thence transferred, after about six weeks, to the growing ponds. The object in this treble and even quadruple transference is to apportion the food to the number and growth of the fish ; only a certain number of fry in the alevin stage are placed in the nurseries at the rate of about 12,000 to the acre. After a few weeks the food

remaining in the pond is insufficient for the growing survivors, and they are therefore turned into larger and deeper ponds at the rate of about 500 per acre, and thence again into larger ponds. The system is desirable only where the waters are not incessantly and largely under renewal, are not rich in natural food, and are not supplied with artificial food; otherwise the periodical transference is unnecessary, since it is merely adopted to regulate the food supply which enables the fish under this system to grow twice as quickly as they do in ponds under the ordinary system, and to be more healthy, since they are not starvelings crowded promiscuously together, but well fed carplets with plenty of room and nutriment. In Geeste where the waters are naturally very poor, this method is essential; the soil in which the ponds are dug is of the poorest, and the ponds are merely filled occasionally with canal water and are not continually changed by a continuous flow.

The object of the construction is to reclaim hitherto useless heath land by alternately growing carp and oats or other hardy cereals or grass. The dry bed of a pond is manured in the usual way and a crop taken; it remains more or less dry (frozen) during the winter, after which the water is let in and a crop of carp taken. These subsist on the fish food in the water, which is rendered more prolific by the balance of the unassimilated manure and the leavings of the cereal crop; the next crop of oats is benefited by the excreta, etc., of the animal crop; gradually the soil is enriched, and with it the successive crops.

The ponds are nicely arranged to avoid undue labour; the breeding and nursery ponds are rectangular with proper sluice arrangements and with central and cross ditches in which, when the ponds are drained, the fry or fish collect and are therefore easily netted, while the growing ponds are just large expanses of water of irregular shape. The canal water is let in by a main sluice, and to prevent predaceous fish from entering with it, the water is strained by having to pass through a semi-circular wall of road metal, which effectually filters it of anything so large as fish fry. From April to November operations continue as above described; a little artificial food is occasionally given such as dry fish powder from Gesstemunde, etc., but this is not relied upon. The resulting fry as seen in July were remarkably vigorous and healthy and gave every promise of a successful crop; they were certainly much better than those of similar age seen two weeks earlier in Bavaria. In November the ponds are drained and the

young fish placed in deep winter ponds for hibernation; in the following spring they are placed in large ponds where they mature till fit for market.

In one pond an experiment was being conducted in the method of leaving the fry and the parent fish in the same pond throughout the season, natural vegetation being encouraged for the protection of the fry. While, on the one hand, the parents probably eat a certain proportion of the fry, on the other hand they destroy a vast number of noxious insects, beetles, etc., which kill an immense number of the fry; moreover the expense of transferring the fry is saved. It is a question of comparative advantages. Apparently the one advantage that this particular experiment has over the ordinary Bavarian method is that only a given number of spawners, and consequently a given quantity of fry, are allowed to a given area.

The results both in gross outturn and net profits are considerable; the balance sheets including all charges, cost of manure, etc., etc., show a very useful net profit, which is surprising when the waste and wretched nature of the land is considered.

The giving of artificial food has been mentioned and it is obvious that since the success of the Dubisch system depends mainly on its proportioning the fish under cultivation to the amount of food naturally available, it is possible by supplying extraneous food to increase the weight of fish grown per acre and per annum, especially as carp respond readily and rapidly to high feeding.

Dr. Hofer of Munich has shown by actual experiment that it is possible so to feed carp that specimens weighing 1½ lb. in spring weighed 5 lb. by the end of July, while Prof. Zuntz of Berlin found that a three-year old carp can be made to triple its weight during one summer. In the hotter parts of America such as California, Mexico, Texas, etc., where the water is warm and full of fish food, carp have attained the weight of 15 lb. in 3 years and have increased at the rate of 1 lb. per month. In China a weight of 30 lb. in 5 years is obtained by supplying abundant food, and in Japan it is common to sell large carp in their second summer, while carp hatched in April grow to 10 inches in length by October when placed in the rich paddy fields in June. The growths obtained by Messrs. Hofer and Zuntz are abnormal being in non-tropical climates and of fish not ordinarily growing to large size; the voracity and excellent digestion of the carp were taken advantage of to stuff them, and they were as unhealthy as Strasbourg geese and died, or would have died, of liver and fatty heart. In tropical

climates, however, carp naturally grow large and fast with the abundant food found in warm waters.

Now artificial feeding can only be resorted to if the prices of the food and of the resulting fish permit, and since it requires 5 to 7 lb. of artificial food, plus any natural food in the water, for every pound of live carp, the food must be exceedingly cheap. Still it is found possible to use some foods and the experiences of Wittingau in Bohemia are interesting. This royal establishment has nearly 200 ponds covering about 25,000 acres, worked mainly under the Dubisch system plus that of artificial feeding. It is here found that carp which, under the ordinary system, weigh 1 lb. at the end of the second summer, weigh 2½ lb. when artificial feeding is added. The food supplied is at the rate of about 6 lb. per pound of carp fished, nearly 60 per cent being lupin seed and 35 per cent meat powder, chiefly waste from Liebig factories. In Bavaria I found that the seed of the yellow lupin was frequently given; it is usually steeped in water for a day or two and then used. Maize cake boiled, steeped or raw—in which last case it is roughly pounded up—was also given. In Geeste I found an excellent preparation of sea fish (undersized haddock, etc., which it is illegal to place as such in the market) which are ground up, bone and all, into a fine meal and desiccated; this was supplied at just over 1 penny per pound, but being too costly is seldom used except for trout. Potatoes, edible oil cakes of various sorts such as groundnut, bran and rice poundings (tavidu), pounded fish scrap, i.e., the flesh of herring, etc., after expression of the oil, vegetables unfit for table use, and so forth, are largely used; as has been already mentioned, the drainage of cattle stalls and manure heaps and the miscellaneous scraps of farms and households are all acceptable to carp, as well as the worms, insects, small molluscs and crustacea found in the fields and in the ponds and ditches.

One is led to enquire whether there is scope for carp growing operations in the Madras Presidency similar to those conducted in Germany. Is there water? Will carp grow successfully in these waters? What methods are available? Will people take the trouble? Well, there is plenty of water, even neglecting the rivers, in the canals, tanks, village ponds, irrigation wells, and paddy fields. True that most of it is non-permanent and dries up in the hot weather; but even this is not a bar to the production of a great crop of food; the rains last only six or seven months, from June to December, but this suffices to grow cereal crops or even two of

them, and with knowledge and some care carp can be grown of marketable size in a few months, with the certainty that whereas a cereal crop is almost useless and unproductive if a severe drought happens, the fish crop will be of material value at any stage, while its in-gathering is even facilitated by the dryage of ponds. The public waters of this class are now engaging attention in view to their better utilization, but there are many which should be dealt with by village bodies or by private effort, such as the village irrigation tanks, village ponds, irrigation wells, and even paddy fields. There are more than 25,000 irrigation tanks in the Presidency, many of great size and some of almost permanent character. The majority have water for a period sufficient to raise a paddy crop and, being mainly fed by surface streams from the cultivated fields, are more or less manured and are known to be full of fish food. The village ponds in many districts are of considerable number, size, and permanence. Half a dozen, ranging from 1 to 3 or 4 acres, were noticed on a short road journey in a district of the Northern Circars almost full of water at the end of last February, and since they adjoin the village-site and cattle stand and are the drinking and bathing sources for cattle, they are full of fish food and literally swarm with small life. In these cases fish would not only grow with rapidity but would greatly improve the character of the water and vastly minimize the growth of mosquitoes.

The permanence of such ponds would be greatly increased by a small expenditure of village hot-weather labour, at present unemployed, in deepening the ponds by a foot or so annually for three or four years, the rich mud, full of vegetable and animal debris, being utilized, as in Germany, for the surrounding fields. The same method is equally applicable to irrigation tanks all of which are heavily silted with washings from the arable area of their catchment basins, further enriched by the exuviæ of tank life. In both cases the double benefit is obtained of increasing the tank capacity and of returning to the fields the loamy and humic matters which have been washed out of them. Irrigation wells aggregate a large area of permanent or semi-permanent water and might be largely utilized for household use. The paddy fields of this Presidency are of vast area, and in many cases contain a good supply of water for many months together. These waters are rich with food, and in Japan the practice of stocking them with carpling is common, the carp being hatched for the purpose in April, transferred in June when 1 inch or 2 inches long to the fields—often many miles distant

—and marketed at a size of 8 inches to 10 inches in October when the paddy crop is over, the rapidity of growth being due to the warmth and abundant supply of fish food in the well manured fields.

As a matter of fact, there are many places which, already swampy or damp, as under canal banks or at the tail end of the irrigation sources, might be converted with little expense into fish ponds, thus turning useless and even miasmatic areas into profitable and wholesome food-producing waters. Travelling recently along the Kurnool canal for about 100 miles, many places were noted below the artificial bank which were quite unutilized for crop growing, being too marshy for dry crops and unsuited, without much preparation, for paddy. Very slight excavation and banking would turn these into permanent ponds, more productive in food and money than the best paddy lands. In areas bordering other canals, e.g., in Kistna, the ground-water level even in areas not actually commanded for irrigation purposes by the canals, is often so high that almost permanent water may be reached at 4 or 5 feet, and the supply could be readily increased by a very low lift, e.g., by cheap windmills, either from the canals or from wells. In Bengal water is occasionally bought for fish ponds from irrigation sources. Where mere percolation-water is not available this plan is often possible under our canals and tanks either by flow or low lift according to the nature of the ground. There is then already plenty of water in this Presidency which may be cultivated with fish instead of merely growing, at best, a haphazard wild crop of fish, and which can be increased in area and permanence by the expenditure of slight capital and labour, and in production by the adoption of simple methods of cultivation.

The remarks just offered as to the nature of Madras waters themselves dispose of the second question, viz., whether carp will grow successfully in such waters. To some extent they are there already, but they merely grow and are not cultivated, while predaceous fish unduly predominate. The waters are precisely those most suited for omnivorous carp. They are full of the matters which, as already mentioned, are those deliberately introduced into German, Chinese, and other fish ponds, while under tropical conditions rapidity of growth is even more probable than in Japan and China. The carp of tropical countries are usually larger and grow far more rapidly than those of European waters. Carp of a single summer may easily exceed 1 lb. in weight since in the warm parts of the United States of America 3 lb. or 4 lb.

per year is a general rate and they have been known to grow 1 lb. in a month. In China 4 to 5 lb. per annum is common, and in Madras water 1 lb. in 70 days is on record. Again, Mr. Thomas has recorded steady takes of 4,000 lb. per annum, without any artificial feeding, from a pond of 4 or 5 acres that had been wholly dried and emptied of all life and restocked with a couple of measures of fry. Hence the chances of really large carp returns from protected areas of the classes mentioned, are excellent. This subject has been treated more at length in paragraphs 179 to 184, 196 to 209, and 232 to 234 of a "Note on Japanese Fisheries" and is engaging the attention of the Fisheries office.

The main point for consideration is what methods of aquiculture are best adapted for such waters. But this would demand a small treatise, which is now under preparation. Meanwhile references may be made to previous articles and to the "Note on Japanese Fisheries" for some indications. Suffice it to say that after a pond has been cleared, as far as possible, of predaceous fish, a few spawners may be introduced and left to themselves or the fry may be bred in separate ponds and introduced in numbers proportioned to the area.

In the case of village or private ponds and wells, growth may be assisted by additions of cheap and available food, viz., leaves and grass such as carp will eat, the berries of the wild fig and other edible fruits such as those of the prickly-pear, the chaff of grain (tavidu), insects collected from the fields and trees by children, silkworm pupæ if available, any cheap edible oil-cake, surplus grain or food from the homestead, spare cattle manure, etc., while a few water plants are valuable as shelters both for fish and for the small life on which fish feed.

Will private enterprise take the trouble to improve existing waters, to form new ponds, to utilize water not merely for irrigation and drinking but incidentally and additionally for indirect food production? Capital is not needed to any appreciable extent even where private persons form ponds for the purpose. A little energy and personal labour, a little trouble in practising a new business, a little patience and intelligence, are the main factors of success in India as in Germany and Japan. The returns in each individual case may not be very great, but neither will be the expense nor the trouble, and the enterprise will not only be purely swadeshi but a distinct and valuable addition to the industries, to the food production, and to the wealth of the country.

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MADRAS FISHERIES BUREAU.

NOTE ON TREATMENT OF SWAMPS,

STREAM BEDS, PONDS, WELLS, POOLS, AND OTHER MOSQUITO-INFESTED AREAS FOR THE DESTRUCTION OF THEIR LARVÆ

BY

HENRY C. WILSON,

Piscicultural Expert to the Government of Madras.

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A NOTE ON TREATMENT OF SWAMPS, STREAM BEDS, PONDS, WELLS, POOLS, AND OTHER MOSQUITO-INFESTED AREAS FOR THE DESTRUCTION OF THEIR LARVÆ

BY

HENRY C. WILSON,

PISCICULTURAL EXPERT TO THE GOVERNMENT OF MADRAS.

THE UTILITY OF FISH AS LARVICIDES.

When we come to consider that the great majority of fresh water fry rely for their sustenance chiefly on aquatic larvæ it seems surprising at first that any larvæ remain to come to maturity in waters stocked with fish.

Immediately after the absorption of the yolk sac the fry commence feeding on minute organisms, such as microscopic crustacea, and, later, on the eggs and larvæ of aquatic diptera.

That they play an important part in keeping down fly pests, such as mosquitos, etc. is an undoubted fact and, if it were not for their presence, we would have millions of mosquitos where we have hundreds now. There is of course a limit to their usefulness in this respect, for, so many mosquito-breeding places exist that are unsuitable for fish, and even in suitable waters surface weeds, etc. protect the larvæ from their enemies.

Chiefly owing to this latter reason the practical utility of fish as larvicides has been decried. The absurdity of this opinion is evident as the fish are not likely to abstain voluntarily from eating the most important item of their natural diet and consequently must take a continuous and heavy toll of larvæ. If the waters are conserved, then a greater percentage of larvæ would be destroyed. Even in the foulest of ill-kept waters they do a certain amount of good, and a careful observer will often see them searching the weed and debris for larvæ and seldom unsuccessfully.

To go to the opposite extreme (which I learn has been done in some cases) of putting oil and cresol into ponds where fish existed, is most unwise and fatal to other small life as well as larvæ. In the first place you not only destroy the fish, but also all small under-water life including other valuable (minute) larvicides, and secondly the effect of cresol and oil is only of a temporary nature and, if not regularly repeated, the pond, etc. so treated becomes a doubly dangerous mosquito-breeding ground.

From a piscicultural point of view the introduction of poisonous substances into waters where fish can be used should be strictly prohibited. The trouble of clearing surface weeds or conserving ponds, etc. is infinitely less than repeated cresoling and oiling and the benefit of the former has the advantage of being more permanent. The cresol and oil treatment is most excellent for, and should be confined to, small isolated puddles or pools too small or of too temporary a character to stock with fish.

SUGGESTED TREATMENT FOR PONDS.

When introducing fish into ponds for purposes of destroying mosquito larvæ, it is necessary to conserve such waters by the removal of surface weeds and floating debris near the margins and draining or filling in isolated pools near the foreshore. The value of this conservancy became apparent to me during my earliest experiments with fish as larvicides. The ponds which were selected for the first experiments were comparatively clear of surface weeds and floating debris and mosquito larvæ could be found near the margin. They were stocked with larvæ-eating fish and after a few days were thoroughly examined with the result that no larvæ could be traced *excepting above some patches of surface weed*; this weed was promptly removed and a further search was made the following day with a negative result.

The margin of ponds, etc. should be trimmed and over-hanging plants that reach to the surface of the water should be cut back, as these tend to hold up debris and protect the larvæ. All small isolated puddles should be filled in or drained. It is just as easy to keep a neat margin to a pond as a neat border to a garden.

BURROW PITS.

The depressions formed when constructing the bunds of irrigation tanks, railways, etc. in India form extensive breeding grounds for mosquitos. The best method I think of dealing with these

burrow pits where it is impossible to drain them, is either to fill them in or treat them similarly to ordinary ponds by clearing weeds, etc. and stocking with suitable fish. Fortunately at the present time a large number of small fish find their way into some of the pits and help to keep the larvæ down. In some districts however, these fish are netted out wholesale by fishermen using casting nets of the smallest mesh. I would suggest that Government adopt the following methods of dealing with these pits :—

(1) If the levels permit, drain the pits off ; if not,

(2) fill in or, where they are extensive and hold water for long periods,

(3) link up each burrow pit by digging an open trench between them, taking care that the sides of the trench are sufficiently sloped to prevent the top soil falling in and blocking them. Clear all pond weeds and debris and stock with suitable fish. These trenches will permit the free access of fish to all the pits and should any of the higher level depressions dry for a short period re-stocking when they fill again, would occur naturally.

(4) Prohibit all fishing in these pits.

(5) When new tanks are being constructed or repairs being made to old bunds make it compulsory to take the earth for the bund from the bed of the tank and not from outside the bund.

SHALLOW SWAMPS, ISOLATED POOLS, ETC.

In dealing with shallow swamps, isolated pools, etc. in malaria-infected districts, I would suggest that the best method would be to trench the entire areas and drain off wherever possible. If it is found impossible to drain a swamp in a malarial tract owing to the nature of the country, then construct a pond at its lowest level and drain the swamp by open trenches into the pond. This pond would have to be kept clean similar to the others mentioned above and stocked with suitable fish. It may be necessary to cross-trench to get at all the little puddles of water held up; but if properly done and kept in order, it would, I think, certainly pay in the long run. Many isolated pools which form from percolation or from heavy rains could in most cases be drained off by these open trenches.

OPEN WATER CHANNELS.

Where water is taken by small open channels for irrigation purposes, etc. in malaria-infected areas its course should be clearly

defined and all obstructions which form little backwaters, removed; the sides should be protected by stone slabs throughout the malarial zone. If this is done the odds against the larvæ in their struggle for existence are enormous and very few are likely to survive. Where cross-channels are taken off the main, care should be taken to avoid the formation of pools, and properly constructed culverts should be adopted. The channel can be made entirely harmless, but generally in the case of a garden supply there is a receptacle for storing small quantities of water; these are sometimes just hollows dug out of the earth, but in many cases small concrete tanks are built; all these should be abolished.

WELLS.

All wells should be kept clear of debris and weed and stocked with suitable fish. In the town of Cuddapah, for example, 50 per cent of the wells were found infested with larvæ of the malaria-carrying mosquito A. *stephensi*. The stocking of these wells with fish larvicides had a very decided and immediate result; heavily infested wells were found free from larvæ three days after the introduction of suitable fish (Haplochilus).

LARGE TANKS.

Mosquitos seldom lay eggs in large, open or wind-swept stretches of water, but select secluded shallows where the wave action is absent. The danger of these tanks generally lies in the unevenness of the foreshore and as the water recedes puddles are left which are inaccessible to fish larvicides. These depressions, where possible, should be drained by trenches into the tank; if the levels do not permit of this, they should be filled in. In fact the whole of the foreshore in the malarial zone should be conserved and all debris or floating matter in the sheltered bays cleared. If stocked with suitable fish when the tank first starts to fill, they will have time to multiply and be of great value in keeping the larvæ down.

PADDY FIELDS.

The destruction of small fish by basket traps of minute mesh should be prohibited in all paddy fields in malarial districts and if larvæ are found after this the fields should be re-stocked with suitable fish. If the above suggestions are carried out the field can be kept comparatively free from larvæ. The paddy fields

form splendid feeding grounds for the small *Haplochilus* and these can be found in large numbers where not interfered with by basket traps, etc. In the Tanjore district and up the West Coast where fish food is plentiful and the paddy fields are not trapped, they simply swarm with small larvæ eating fish, especially *Haplochilus*.

ESTUARIES, BACKWATERS, SALT AND BRACKISH POOLS NEAR THE COAST.

A careful search should be made along the shores of the estuaries and backwaters and all isolated pools within the malarial area should either be filled in (if small) or an open trench dug into the estuary or backwater to enable fish to have clear access. All sea-weed and decomposing debris should be removed from these pools. Fish will soon discover the larvæ and rapidly destroy them. At Ennore where most of the breeding places inside a prescribed area were filled in by Major Ross, I discovered a salt water pool on the shores of the backwater with one living mass of larvæ. As their breeding areas had been restricted the mosquitos had evidently bred in this small pool in thousands. It was shallow, not more than 6 to 8 inches at the deepest part, but was cut off from the backwater by a small sandbank. I divided this pond into sections and cut a channel from one into the backwater deep enough to allow small fish a clear passage. I removed all sea-weed and debris from both sections and examined the following morning. Fish were found in the one section and most of the larvæ were destroyed, only a few remaining in the shallowest portion; whereas in the other isolated section they were teeming. The sides of the former were sloped to make it deeper round the margins and the same evening an examination proved the fish had cleared the lot of larvæ out of the section opened to the backwater. Backwaters as a rule when open to the sea contain an abundant supply of larvicides in the way of small fish, and an examination along the shores where fish have free access will prove that there are very few larvæ; but, on the other hand, when the bars of the backwaters are closed and netting is carried on along the margins by men using small mesh nets, you will find numerous mosquito larvæ. The supply of fish larvicides is depleted and no fresh supply can come in from the sea. In the case of brackish isolated pools where it is either too expensive or

difficult to fill them in, they should be drained and attended to similarly to fresh water ponds or stocked with suitable fish as per list given below.

STREAM BEDS.

All stream beds should be conserved where they pass through malarial zones. To carry this out effectively the banks require to be given a gentle slope to the normal bed of the stream where the channel should be clearly defined throughout its course within the malarial area. Where the natural flood banks are very wide apart and where hollows exist between them and the normal channel holding water for considerable periods, these should be, if the levels permit, linked up by trenches and drained into the main channel or filled in. If the normal bed of the river is swampy and overgrown with reeds and grass, these should be cleared and an uninterrupted defined course given to the normal stream. Where there is a tendency for the river to form a subsidiary deep course during floods, permanent sections to be formed about every 100 feet to prevent future scouring and to facilitate the recovery of the sections of bed if erosion ever occurs. The waters should be stocked with suitable fish larvicides and fishing strictly prohibited.

Hollows formed by the action of running water and stones on the surface of rocks in river-beds form ideal breeding grounds for mosquitos, where the larvæ are free from most of their enemies. These places can often be found black with mosquito larvæ, and I would suggest where they exist in malaria-infected areas to have their water holding capacity destroyed. This could be done either by filling in or by dynamite or in most cases with a stone mason's chisel and hammer by simply knocking a drainage channel into each hollow. As it takes many years for these to form, the above measures need not be repeated for a long period. To fill them in, portland cement would be advisable.

CASUARINA PLANTATIONS.

Holes dug for the purpose of obtaining water for young casuarina trees form most dangerous mosquito-breeding places and these can be found in every plantation along the coast. The water from these pits is only required during the dry months of the first two years after planting, and the holes containing water remain for many years afterwards untouched and unused. There is not the slightest reason why these should be allowed to remain

forming as they do dangerous mosquito-breeding grounds. In the interests of public health the Government might compel the owners of plantations to fill up all such pits, but in any case these danger zones should be abolished.

COCOANUT PLANTATIONS.

In many cocoanut plantations especially on the West Coast it has been the custom to dig trenches about four feet deep and extending a considerable distance among the trees. The water in these trenches appears to be used largely for soaking cocoanut leaves for purposes of making thatties and consequently becomes very foul. Mosquito larvæ can always be found in these places in large numbers.

It is useless stocking them with fish for the following reasons, viz. :—

(1) It is impossible for the fish to destroy the larvæ owing to the presence of the soaking cocoanut leaves and other debris.

(2) After a time owing to the foulness of the water the fish become sick and eventually die.

As these trenches do not serve any very useful purpose they should be filled in.

STREET DRAINS.

Badly constructed street drains where water is held up, are always infected with mosquito larvæ. The constant cleaning of drains that have a natural earth bottom causes inequalities or depressions which hold water for periods sufficiently long for mosquito larvæ to come to maturity.

If sufficient fall can be obtained, then it is best to build a pucca drain with concrete sides and bottom. If it is impossible to get rid of all water, then kerosine oil should be used freely at least once a week.

DRAINAGE CHANNELS ON THE SEA COAST.

All drainage channels which are subject to tidal influence are generally found free of larvæ and well stocked with larvæ eating fish. But wherever these are obstructed by cross bunds they form dangerous mosquito-breeding grounds. All obstructions should be removed and the highest reaches possible brought under tidal influence.

MOST SUITABLE GROUNDS FOR MOSQUITO LARVÆ AND THEIR NATURAL ENEMIES.

The places selected by malaria-carrying mosquitos for depositing their eggs are very numerous and vary from large swamps, ponds, etc., down to the small collection of water in the hollow of a tree or broken chatti pot.

During Major T. S. Ross's inspections in Southern India on special malarial duty he generally found the malaria-carrying anophelines under the following conditions, viz. :—

A. *culicifacies* is most ubiquitous in its selection, but generally prefers clear water.

A. *barbirostris* in tanks, shady pools, pot holes in rocks, stagnant waters, etc.

A. *fulliginosus* in marshes, swamps, paddy fields, etc.

A. *stephensi* in wells, puddles, cisterns, etc.

A. *willmori* in hill streams and marshes.

NATURAL ENEMIES.

Where tall reeds (jambu grass) exist, not many anopheline or other larvæ can be found and I put this down either to the small fish or to the presence of minute crustaceans. Some years ago (1909) I observed some of these crustaceans (*Daphnidæ*-fam.) attacking the eggs of a species of Yellow dun (*Ephemeridæ*) very common in the Kurnool-Cuddapah Canal. Again when hatching experiments were being carried out with the eggs and fry of *Ophiocephalus striatus* both were attacked and destroyed by these minute crustaceans. I identified the most persistent of these as "Daphne pulex," and the method of attack on the fry was to bite into the embryonic caudal fin and tap the caudal vein. The little fish soon died from loss of blood. Mosquito larvæ were introduced into the tank and they were promptly attacked and killed. The method adopted in this case appeared to consist in nipping off or pulling out the long lateral hairs until the larvæ were unable to regain the surface and so dropped to the bottom where they were seized and evidently their vital juices extracted. That they are valuable larvicides is undoubted as they swarm amongst the reeds of most tanks.

The larvæ and full grown beetles of the *Dytiscidæ* are also useful enemies of mosquito larvæ.

Another larvicide common in stagnant waters is the Notonecta glauca.

The young of most of the fresh water indigenous fishes of India attack and destroy mosquito larvæ: but as some grow to a large size they are only useful during the fry stage. In selecting the best of the larvicides it is only necessary to include those that rely chiefly on the larvæ for their food supply it being their natural diet. The following selection will be found a very useful one, the geographical distribution of each genus being widespread:—

FOR TANKS, BIG PONDS AND SWAMPS THE FOLLOWING ARE MOST SUITABLE, VIZ.—

Genus-*Chela.*

Description of genus (Dr. Day)—Body elongate and compressed: abdominal edge cutting. Mouth directed somewhat upwards with the lower jaw prominent. Barbels absent. Pharyngeal teeth hooked and slender, in two or three rows. Dorsal fin short, without any osseous ray, situated principally or entirely opposite the anal, which latter has an elongated base. Pectorals long. Caudal forked. Scales of moderate or small size. Lateral line concave.

Geographical distribution (Dr. Day)—Sind, Continent of India, Burma, and extending to Malay Archipelago.

These fish are surface feeders and their chief diet consists of flies and larvæ. (All species good, the smaller ones being the best.)

Genus-*Rasbora.*

Description of genus.—Abdomen rounded. Cleft of mouth oblique, lower jaw slightly prominent, having one central and on either side a lateral prominence, fitting into corresponding emarginations in the upper jaw. Barbels two (rostral) or none. Eyes with free lids. Pharyngeal teeth. Dorsal fin without any osseous ray and few branched ones, inserted posterior to the origin of the ventral, but not extending to above the anal, which latter is short. Scales large or of moderate size. Lateral line concave continued to the middle or lower half of the caudal fin. Gill rakers short.

Geographical distribution.—Africa, India, Ceylon, Burma to the Malay Archipelago.

All species.

Genus-*Barilius.*

Description of genus.—Abdomen rounded. Mouth anterior, sometimes oblique, having a moderate or deep cleft. Jaws compressed,

the lower usually with a knob above the symphysis, and an emargination to receive it in the upper jaw. Barbels four, two or none: occasionally very rudimentary ones are present. Pharyngeal teeth in two or three rows, hooked. Dorsal fin without osseous ray, of moderate length, inserted posteriorly to the ventrals, sometimes extending to above the anal, which latter is somewhat elongated. Scales of moderate or small size. Lateral line concave, continued on the middle or lower half of the caudal or incomplete or absent. Gill rakers very short or even absent.

Geographical distribution.—India, Ceylon, Burma, Malay Archipelago: also found in the Nile and East Africa.

Small species best.

Genus-*Haplochilus.*

Description of genus.—Body somewhat elongated and compressed. Upper surface of head and nape broad and depressed. Teeth villiform in the jaws, present or absent in the palate. Dorsal fin short, commencing behind the origin of anal, which latter has an elongated base. Scales cycloid and of medium size. Lateral line absent. A white occipital spot invariably present.

NOTE.—This occipital spot is under control and if the small fish is frightened or for other reasons it can render it invisible.

Geographical distribution.—India to the Malay Archipelago and beyond, tropical Africa, Madagascar and islands in the Indian Ocean: also temperate and tropical America.

All species good.

Genus-*Barbus.*

Description of genus.—Mouth arched and anterior or inferior. Jaws closely invested by the lips, which may have leathery lobes but no horny covering. Barbels four: or two: or none. Eyes without adipose lids. Pharyngeal teeth. Dorsal fin rather short, commencing nearly opposite the root of the ventral: its last undivided ray being either ossified and serrated or entire or articulated and not osseous: and rather short in some species its second ray ossified or its last undivided ray may even be serrated. Scales large, of moderate or small size, anal scales not enlarged. Lateral line may be complete or incomplete, when the former it is continued to opposite the centre of the base of the caudal fin.

Geographical distribution.—Throughout Europe, Asia and Africa.

The small species of this extensive genus are most valuable larvæ destroyers.

FOR PADDY FIELDS, WELLS AND SMALL PONDS, ETC.—

All species of *Chelas, Haplochilus* and *Polyacanthus.*

FOR SALT OR BRACKISH WATER PONDS, ETC.—

Genus-*Therapon.*

Description of genus.—Branchiostegals six. Eyes of moderate size. Opercle with spines. Preopercle and sometimes preorbital serrated. Teeth villiform in both jaws, the outer row being sometimes the larger: deciduous ones on the vomer and palatines. Dorsal fin single but more or less notched, having from eleven to thirteen spines: anal with three. Scales of moderate or small size. Air vessel divided by a constriction.

Geographical distribution.—From the Red Sea and East Coast of Africa through the seas and estuaries of India to the Malay Archipelago and north coast of Australia.

"*Therapon jarbua*" is a most useful species and can be found in all backwaters and will live and thrive in brackish and fresh water ponds.

Genus-*Polyacanthus.*

Description of genus.—Body oblong, compressed. Mouth small and but little protractile. Opercles spineless. Teeth small and fixed in the jaws, palate edentulous. Dorsal fin single, the spinous portion of much greater extent than the soft: the anal of a similar description: ventral with one spine and five well developed rays, some of which are usually elongated. Scales rather large, ctenoid. Lateral line interrupted and may be partially or even entirely absent.

Geographical distribution.—Fresh waters and estuaries along the coast of India and Ceylon.

"*Polyacanthus cupanus*" is a most valuable larvæ destroyer for both fresh and brackish water, and can be carried any distance with the greatest of ease without change of water, as it obtains oxygen direct from the atmosphere.

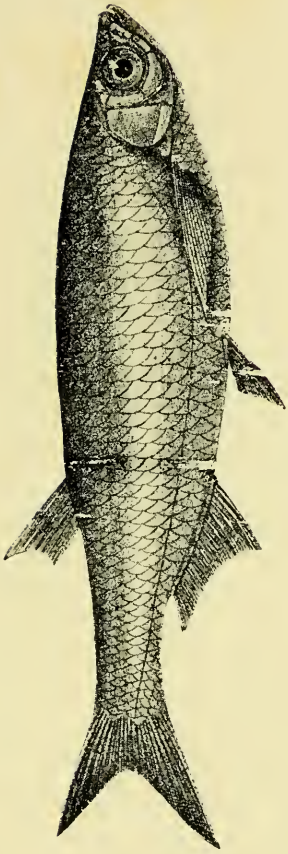
DESTRUCTION OF IMMATURE FRY AND USEFUL LARVICIDES.

The practice of trapping streams by inserting fixed engines (basket traps Plates 7–9) from bank to bank and the use of fine mesh nets the strands or meshes of which would not allow the smallest fish to pass through, is a most destructive method of fishing.

As it is in the interest of public health to preserve as many of the small fish larvicides as possible, some action to prevent their wholesale destruction is absolutely necessary. If such fishing cannot be abolished altogether the mesh of nets or interstices of basket traps should be regulated and the users licensed. In districts where this is carried on to a large extent mosquitos are naturally most prevalent.

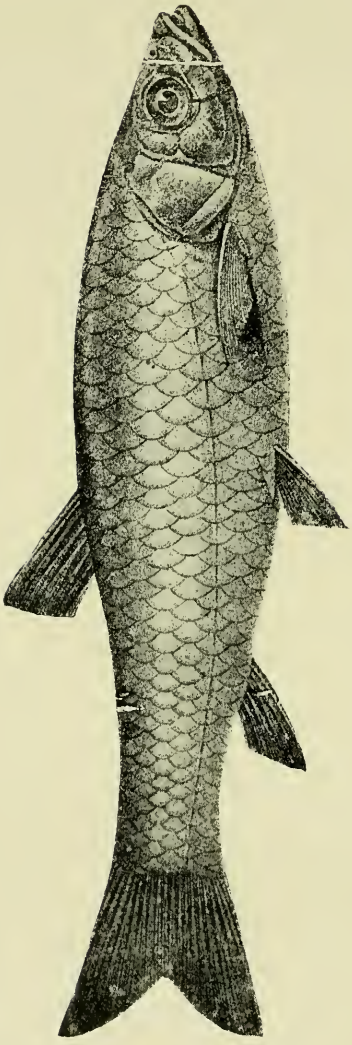
H. C. WILSON,
Piscicultural Expert to the Government of Madras.

(CAMP) KURNOOL,
Dated 6th February 1914.



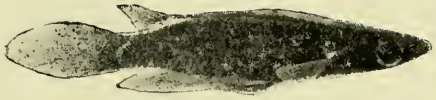
Chela Argentea.

PLATE NO 2



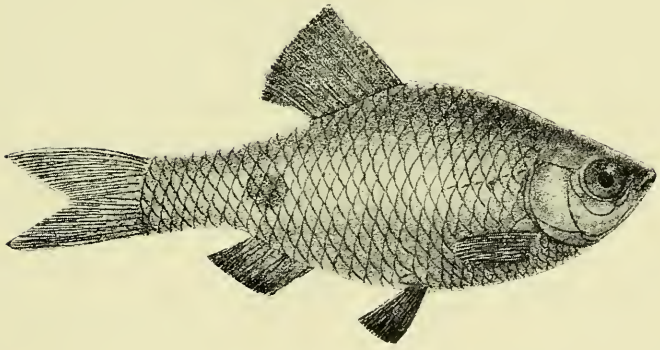
RASBORA DANICONIUS

Plate No. 3.



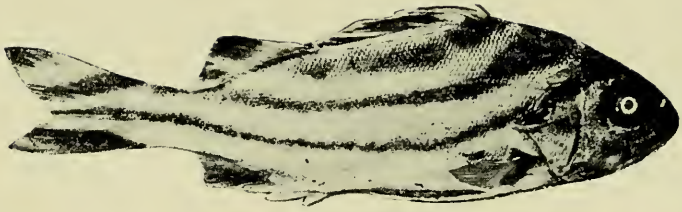
Haplochilus Lineatum.

Plate No 4.



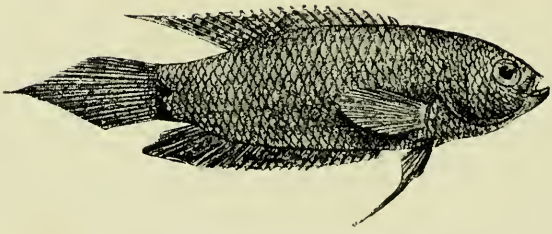
Barbus Ticto.

PLATE NO. 5.

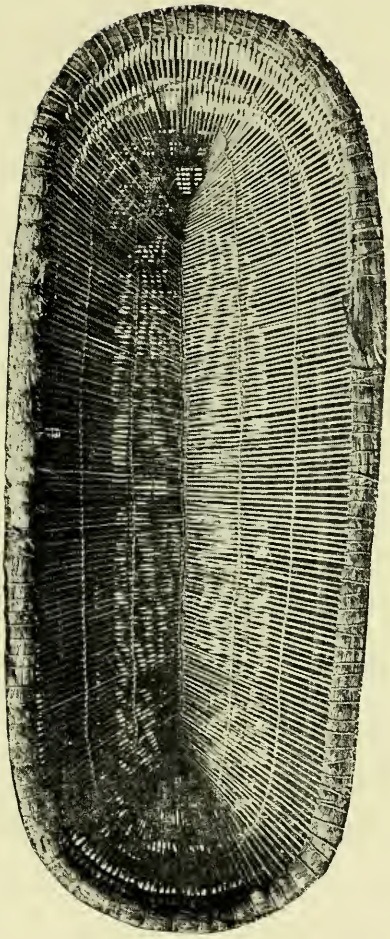


THERAPON JARBUA.

PLATE NO 6.

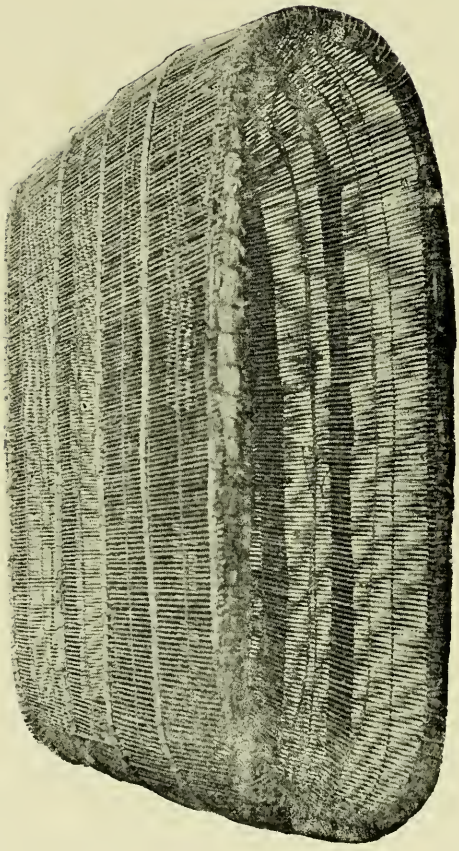


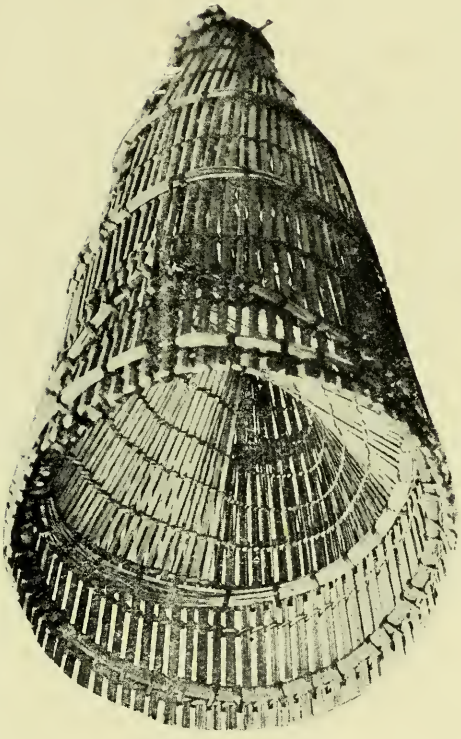
POLYACANTHUS CUPANUS



Basket Trap.
Largely used for capture of small Fish.

PLATE NO. 8.





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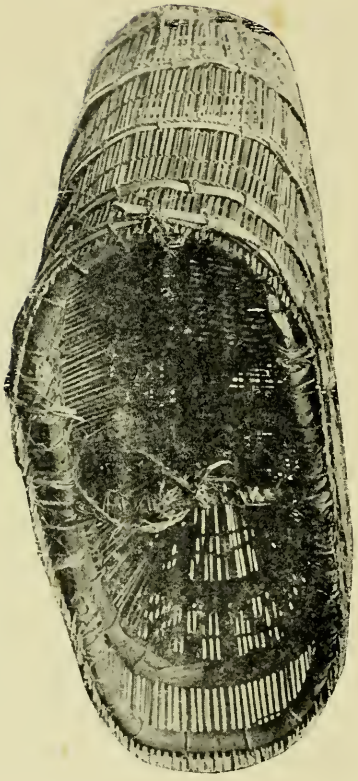

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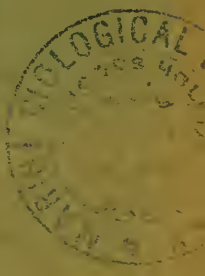
MADRAS FISHERIES DEPARTMENT

ADMINISTRATION REPORT

FOR THE YEAR

1917-18



BY

SIR F. A. NICHOLSON, K.C.I.E.

Honorary Director of Fisheries

Report No. VII of 1917

Madras Fisheries Bulletin, Vol. XI, pages 173 to 207

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Marine Biologist's branch (*Mr. James Hornell, F.L.S.*).—The Tuticorin fish-farm, the edible oyster farm at Pulicat, the preparation of marine zoological specimens for educational work, beche-de-mer preparation, scientific and practical investigations, and the writing of bulletins.

Pearl and chank branch (*Mr. James Hornell, F.L. S.*).—Pearl and chank work over the whole coast from Madras to Cape Comorin, and miscellaneous.

Pisciculturist's branch (*Messrs. V. Govindan, B.A., F.Z.S., and B. Sundara Raj, M.A.*).—The Sunkesula fish-farm, that at Ippur, larvicidal work, the breeding of fish new to inland waters, such as gourami, etroplus, tench, the stocking of tanks, the conservancy of various waters, the beginnings of a very detailed and systematic survey of the waters of the Presidency in view to systematic stocking and culture, the preparation of several distinct schemes such as the piscicultural utilization of the great new irrigation reservoir at Mopad, the cultural and sanitary development of the Chingleput Fort moat, and a similar scheme at Vellore Fort, and the beginnings of investigation into the better fishing of deep water and quasi-permanent tanks in the Presidency. During the year the soap works were separated from "Fisheries" and handed over to "Industries," remaining however for the present under the general supervision of the Honorary Director in his individual capacity and not as the Honorary Director of Fisheries.

5. *Director's branch.*—Technical work at Tanur and the Cannery proceeded on normal lines, and there is nothing to need special mention; cannery operations were somewhat larger than in the previous year but quite insufficient for the general demand, and the net profit, as shown below, considerably greater. The motor sea-going launch "Leverett," built and engined by Messrs. Brunton of Cochin and an excellent boat, was delivered towards the close of the canning season and was then sent to Tuticorin, where she was of great service and effected considerable economy in towing chank canoes. The work of the fishing machwas (Ratnagiri pattern boats) belonging to the department was very unsatisfactory, and will have to be reorganized.

A scheme for the refrigeration of cheap shoal fish (sardines, mackerel, catfish, etc.), was elaborated and freezing tanks have been built at Tanur; the scheme, which is purely experimental, will be put in operation at once. The idea is to see whether,

operating on cheap but good fish, fresh fish can be successfully placed in distant markets by sharp freezing in ice and salt, and in an extended zone of adjacent markets by simple chilling.

6. *Oil and guano operations.*—As reported in previous years there are some 253 private oil and guano factories on the West Coast, which have sprung up since and in consequence of the department's operations in 1908-09. Owing to the war and consequent absence of freight, and in part also to short distribution and lessened fat contents in the fish, many of the factories, especially in Malabar, have had very bad times either from want of products or from inability to sell them. The absence of freight led to such cessation of sale that where products were fairly abundant, guano, ordinarily priced at Rs. 70 per ton was unsaleable at Rs. 30, and oil ordinarily worth Rs. 150 was unsaleable at Rs. 40. Fortunately, the Controller of Munitions made requisitions upon the Department for oil for military purposes, and this, coupled with a sudden demand by the jute mills, brought prices back to normal and greatly benefited the industry; this Department supplied about 50,000 gallons of oil. Not only so, but since certain Military departments require superior oil, the manufacturers were in many cases induced to prepare and supply these better qualities, and under direct departmental instruction and stimulation, have produced and can produce very superior oil even beyond the requirements of the customers. This matter is now being followed up.

7. As regards guano this department, through Mr. V. Govindan, stimulated the formation of groups of producers, and acting as intermediary with large customers obtained sales to a considerable amount which have sent up the prices to normal. It is hoped to make these groups permanent and bind them in a completer union by forming them into co-operative societies. Doctor Anstead, Deputy Director of Agriculture for Planting Districts has earnestly pressed upon me the need for bringing producer and planter into direct touch, and the matter will be specially dealt with during the coming season.

8. *Inshore fishing experiments, Madras.*—On the initiative of Mr. V. Govindan who also took charge of the matter, a very useful experiment was made in bringing two West Coast canoes, nets, and 14 men over to Madras to fish Madras waters with the harbour (by special permission) as base. The experiment was for a year and

began in June 1917 and lasted till June 1918. It was then closed by the Honorary Director, perhaps prematurely, and Government have now been moved to sanction a revival of operations on a three-year term and on a wider basis. For though the experiment, like most novel experiments, did not fully pay for itself yet (1) a large amount (53,000 lb.) of fish was caught, some under circumstances when catamarans could do nothing in the way of capture of valuable shoal fish for which the agile Malabar canoes and large nets are specially fitted; (2) it was the cost of bringing over the boats and men, the very high pay, rations, and house-rent necessarily given to induce West Coast men to come to Madras and remain away from their families, and a considerable sickness of the crews due to the unaccustomed "water" of Madras, that prevented full financial success. With wages charged at Madras rates, that is such as would be payable to local men hired by local enterprise there would have been substantial profit. Hence and because the experiment created local interest (though at first regarded and treated with hostility) a more thorough testing of the experiment is desirable, local crews being recruited if possible, and other boats, nets, lines, and methods tried. The experiment cost, all told, Rs. 4,406-6-11, and the fish caught realized Rs. 3,044-12-0.

9. *Socio-economic work.*—Mr. V. Govindan, as usual, has been busy in stimulating progress, and has visited in his propaganda, most of the important villages on the coast, some of them several times. At the beginning of the year there were, in existence on the West Coast, seven credit societies all based on thrift: during the year three credit and one productive society were registered, while, eight credit societies and one productive society applied for registration. Of the three new credit societies one opened at Rayapuram (Madras), being the first started on the East Coast by direct departmental work. Three are reported by Mr. Hornell to have been opened among fishermen on the Ramnad coast by the Registrar for co-operation. Of the productive societies one has been formed by oil and guano producers in the Mangalore taluk, and it is hoped that its formation will lead not only to increased production and better sales, but to better classes of goods, since, like the Japanese guilds, the society will refuse products not up to standard. The other productive society waiting registration, is that at Thalayi, and is to be a society of curers which Government is aiding [G.O. No. 742, Financial (Separate Revenue), dated 4th September 1917].

10. The nine societies at work (exclusive of Rayapuram for which figures are not available) had, on 30th June 1918, 884 members of whom 187 were females, holding 1,103 shares and with "own" funds, actually collected, of Rs. 10,265; loans were issued for Rs. 18,209, of which Rs. 4,058 were for the paying off of prior (often usurious and enslaving) debts.

An encouraging feature of the year's work was that fisherfolk have begun to invite Mr. Govindan to visit the villages and organize societies.

11. In the matter of co-operation in general among the fisherfolk, fairly definite proposals have been made to Government, as read in G.O. No. 2049, Revenue, dated 27th May 1918, in which Government have laid down that the development of the communities is a primary duty of the Department and hope that the spread of co-operative methods among the fisherfolk may be accelerated.

12. *Temperance.*—Two societies continue to do good work and to progress, notwithstanding factious troubles; out-members have been recruited from villages where there were not enough to form independent societies. Mr. Govindan mentions as a reason for intemperance additional to those formerly adduced, that the fishermen's cults require offerings of drink to their deities and that consequently what is good for gods cannot be bad for men, a belief which has classical warrant but does not excuse or explain the intemperance of Christian fishermen as so often mentioned by Mr. Hornell. There is much to be done in this way, and Mr. Hornell mentions the good effect of coffee and tea shops for the men employed in his branch of work. On many parts of the West Coast tea and warm drinks (temperance) are sold on the beach or close by, to the fishermen so that the idea, being in indigenous practice may be spread by a diligent propaganda and practical example. I have been favoured with an important letter from the Board of Revenue (Salt and Abkāri) desiring to enlist our aid in the provision of "coffee shops" in place of toddy shops, a philanthropic suggestion of the highest importance and interest.

13. *Education.*—Not much new work has been done, but in the papers read in G.O. No. 2048, Revenue, dated 27th May 1918, general proposals have been made and concurred in by the Director of Public Instruction (the Hon'ble Mr. Stone) whose sympathy with the proposals is of the highest value. Government have generally accepted the suggestions and have ordered definite proposals, which are now occupying attention. It is quite certain that the

people themselves are beginning to wake up to the need for education, and that it will be welcomed, especially in the somewhat wide form which has been suggested, both on literary, technical, practical, and social lines.

14. *Mr. Hornell's work.*—As Mr. Hornell's report both as Marine Biologist and as Superintendent of Pearl and Chank Fisheries, is printed almost in full, repetition here is needless. Owing to financial exigencies the projected Krusadai Pearl Oyster Farm, where pearls are to be "induced" and grown under complete control has had to be postponed "for the duration"; the biological station and new aquarium at Madras with headquarters therein for fisheries, has similarly been postponed, and still more regrettably, the exploration of the deep sea by a special vessel.

The chank fishery yielded good results and profits, though the number of shells fished was much smaller than expected, owing to various reasons. A trial expedition to fish the Ceylon chank beds which are free to all comers resulted favourably, and is being repeated. Statement I annexed to this report gives an abstract of expenditure and receipts in the Marine branch and Statement III gives details for the chank fisheries. For further details the report may be consulted.

15. *Inland waters.*—Similarly the pisciculturist's report is printed almost in full.

It may be noted that the gourami obtained from Mauritius and Java have now bred successfully, so that a considerable stock of these very valuable food fish is in hand; so also of Etroplus; the tench introduced from the Nilgiris have not yet bred.

Certain important items are briefly mentioned in paragraph 4 supra; more details will be found in the report.

An important experiment in fishing deep water tanks was at last initiated. In this Presidency, the irrigation tanks in general are exhausted of water in a few months when, of course, all fish in the tanks would perish except those which, like murrel, aestivate deep down in the mud. Hence the universal method of fishing is to await the fall of the water almost to exhaustion when, by a general battue, practically all the fish are captured. But if the tank is deep and contains permanent water or obtains supplies which keep up the level for a year or so, the tank remains unfished for want of any fishing material or method; in other words, precisely when conditions are favourable for the growth of a large head of fish, such fish are left uncaptured, so that the food supply

obtained is a minimum and the rentals fall to nil. There is a good number of such tanks, and experiments were made to ascertain the best methods of fishing them; boats, nets, and men were engaged and our own staff supervised operations, which, however, have not yet been concluded; unexpected difficulties cropped up, e.g., in the way of weeds, the opposition of persons interested in keeping off outsiders, and so on, but it is obvious that on tanks which, like some of the Sangam tanks, Mopad, etc., contain large bodies of water permanent or practically so, common sense methods must eventually succeed. Statements I and I (*a*) give an abstract and details respectively of expenditure and receipts in this branch.

16. *Miscellaneous.*—It was found impossible to take over from the Salt department any of the fish-curing yards for direct departmental control, as sanctioned by G.O. No. 752, dated 10th September 1917; that will be a main item of work in 1918–19.

Bulletins Nos. 10 and 11 were published, the former containing annual reports, 1908—1917 (pages 179), and the latter containing the Madras Fishery Investigations, 1917 (pages 172).

The department exhibited at the Madras Exhibition of Industries, 1917–18, and was awarded a gold medal and diploma of excellence for canned and cured fish.

There were several useful inquiries from outside during the year; one by the Hon'ble Mr. Godbole of the Bombay Legislative Council regarding oil and guano factories; on my reply a council resolution in favour of further inquiry and support of such factories was accepted by Government subject to the report of the Industries Commission; Mr. Mead, I.C.S., Director of Industries, Bombay, also investigated our fishery and soap industries, and in June Mr. Christie, I.C.S., of Burma was placed on special duty by his Government for a similar inquiry now proceeding, in view to the establishment of similar work in Burma.

17. *Finance.*—By G.O. No. 2614, Revenue, dated 11th July 1918, receipts and charges are to be classified under five heads, viz.:—

I. Supervision and research;
II. Marine fisheries;
III. Inland fisheries;
IV. A. Factories,
B. Vessels;
V. Capital expenditure;

in view to ascertain "the profit or loss under head of work",

By this Government Order while the main portion of all salaries, establishment allowances, travelling allowance and contingencies, is debited to "I. Supervision and Research" a considerable portion (one half in the factories) is debited to the specific operations on which the staff are employed. This conveniently distributes the total cost of the staff so that while an equitable amount is debited to quasi commercial work (i.e., factories), that due to "Experiment and Research", which necessarily bulks large in such a department, is debited accordingly. Similarly with regard to IV-B. "Vessels", the total running cost of the boats owned by the department (other than the "Lady Nicholson" and other boats of the pearl and chank branch) is debited to "Vessels", and anything earned by them, e.g., in supplying fish to the cannery and to Tanur, is credited to that head. Pearl and chank fisheries are now included under "II. Marine Fisheries" instead of forming a separate head of account and report.

18. Statement I in the appendix gives in one view an abstract under all five heads, and shows that on tallying current expenditure (Rs. 2,20,049) with income (Rs. 2,26,230) there is a net credit balance of Rs. 6,180. Considering that a sum of Rs. 59,100 forms the expenditure on "Supervision and Research" plus a considerable proportion of salaries, etc., debited to and entered under the other heads, the result is very satisfactory and is due to the net profits on chanks, fishery rentals, and experimental factory operations, such net profits being almost entirely due to departmental work in the initiation or development of resources and operations.

Moreover when comparing expenditure and receipts it should be noted that whereas the heavy amount under item I is for fifteen months, receipts such as rentals whether of chanks or of inland waters, are mainly for one year only, so that item I which is wholly an item of expenditure, is disproportionately heavy when compared with receipt; the credit balance would be still greater if item I were taken for twelve months only.

19. It should be noted, however, that the actual cash outlay of the year was Rs. 2,42,478, or Rs. 22,429 larger than that entered (Rs. 2,20,049) as current expenditure; this mostly represents capital expenditure (Rs. 19,399) of which, by Government Order only 10 per cent is entered (being depreciation) as *current* expenditure; hence Rs. 1,939 are entered under current account instead of Rs. 19,399. The capital expenditure is given in detail in the first column of Statement I (*a*) and includes Rs. 3,750 for a motor-car,

subsequently however resold for Rs. 3,800 (not yet collected and therefore not included in "receipts"), Rs. 7,821 as the total cost of the motor launch "Leverett", and Rs. 3,560 for new sheds and plant at the cannery. Capital outlay, minus depreciation, remains of course as an asset, and merely represents the transmutation of cash into property.

20. Statements I (*a*) and I (*b*) give details under the several heads. Statement II is the list, ordered by Government, showing tanks at present stocked and leased by the department. Statement III gives the result of the chank fisheries for the year.

21. Statement IV gives the trading and profit and loss accounts for the cannery. The expenditure side in these accounts differs from that in Statement I which only shows drawings from the treasury, whereas Statement IV gives on one side the expenditure cash and of materials from stock, and on the other the receipts inclusive of stock in hand (taken at cost price) at the close of the year. This of course is the usual manufacturing method and gives a true account of results. The profit and loss account shows a net profit of Rs. 8,151 on cannery operations after deducting all charges for staff, operations, depreciation and interest.

22. Statement V is similar for Tanur and shows a net loss of Rs. 997. This is due to the small output of a factory carrying on a series of comparatively small operations, which though technically and commercially successful, were insufficiently large to cover the disproportionate cost of establishment. Moreover the year in Malabar was very bad for oil and guano operations; a few extra tons of fat sardines would have converted the deficit into a profit. The loss is really debitable to research as the factory is mainly experimental.

23. Notwithstanding then the heavy expenditure for "Supervision and Research" and for experimental work, and the fact that these objects cover fifteen months' expenditure as against only twelve months' receipts in certain large items, the departmental balance sheet for 1917-18 is not unsatisfactory. Moreover, in perhaps the current and certainly in subsequent years, the net income should be considerably increased by operations already begun or beginning, such especially as the fishing of existing deep water tanks, e.g., those of the Sangam and Nellore works and the new Mopad reservoir. It is further to be noted that the income of the department is obtained without raising a single anna by

taxation, licences, or other charges on the fishing folk or on the public.

24. Nevertheless I desire here to disclaim any idea either of measuring the success of the department by its balance sheet, or of narrowing its scope and objects by considerations of immediate departmental profit and loss. Its primary object is not revenue but development and progress; revenue is incidental and while welcome as a fiscal contribution and as a fund providing for further expenditure, is not a direct object save as an *evidence* of success in concrete fishery operations. Even as such evidence it is imperfect; e.g., Tanur shows a loss on the whole yard, yet, as stated in paragraph 22, the several curing operations were successful in themselves both technically and commercially, and needed only to be larger to show financial profit; these operations and investigations are the basis of future curing operations throughout the Presidency and, in the matter of fish oil and guano, have already resulted in nine years in 253 private factories and a great and developing industry and trade. The department is one which, for the good of the consuming public in general and of the fishing classes in particular, must be primarily a spending department, spending State funds on well considered plans for improvement and development, and the right questions are, in fact, how money can most usefully be expended, on what objects, and to what extent. The department is mainly concerned with *service*, and the profits sought are not departmental cash profits but the introduction of improvements, the progress and profit of the fisherfolk with the fishing and allied industries, and the economic benefit of the State in general.

ENCLOSURES.

(1)

Letter—from J. HORNELL Esq., F.L.S., Government Marine Biologist and Superintendent, Pearl and Chank Fisheries, Tuticorin.

To—the Honorary Director of Fisheries, Madras.

Dated—Tuticorin, the 2nd/8th June 1918.

I have the honour to submit the following summary of the work done in the Marine section of this department for the year ending 30th June 1918 in respect of the Pearl and Chank Fisheries and for the fourteen months' period ending 31st May 1918 in respect of the other branches of this section. The usual annexures are appended.

2. Operations were carried on upon the same general lines as in the preceding year. No new developments could be taken in hand in consequence of the stagnation of progress due to the effects of the war.

3. *Financial results.*—The year's work has been most satisfactory, especially in that connected with the Chank Fishery. The expenditure, revenue and net profits of the various sections of this industry are as follows:—

—	Expenditure.	Receipts.	Profit.
	RS. A. P.	RS. A. P.	RS. A. P.
(1) Tinnevelly Pearl and Chank Fisheries	19,926 7 0	16,689 13 1	—3,236 9 11
(2) Ramnad Chank and Beche-de-mer Fisheries	28,813 3 7	71,069 5 8	42,256 2 1
(3) Sivaganga Chank Fishery ...	246 13 6	269 13 5	22 15 11
(4) Tanjore Chank Fishery ...	...	4,890 0 0	4,890 0 0
(5) South Arcot Chank Fishery ...	...	900 0 0	900 0 0
(6) Chingleput and Nellore Chank Fisheries	...	600 0 0	600 0 0
(7) Ceylon Chank Fishery... ...	3,029 5 5	4,577 6 3	1,548 0 10
Grand total ...	52,015 13 6	98,996 6 5	46, 980 8 11 or

Rupees 39,278-5-9 deducting supervision charges, viz., Rs. 7,702-3-2.

4. For the purpose of comparison with figures given last year, the total net profit should be taken as Rs. 57,121–12–9, excluding the charges under "Pearl Fisheries" such as maintenance of the Motor Inspection Schooner "Lady Nicholson," etc., as the same were not included last year. This total net profit compares satisfactorily with that for the preceding year, Rs. 53,247–4–8 as the substantial increase of Rs. 3,874–8–1 has been made. The chief advance is in the Ramnad fishery due to an increase in the catch of shells, 264,760 in 1917–18 as against 254,221 in 1916–17.

5. The financial aspect of the minor branches of semi-commercial work is shown as under:—

	Expenditure.	Receipts.	Profit.
	RS. A. P.	RS. A. P.	RS. A. P.
Marine Fish farm ...	684 6 7	1,496 7 0	812 0 5
Pulicat Oyster farm.	1,124 5 9	843 6 6	280 15 3 (Loss)
Zoological supply ...	302 11 11	735 11 0	432 15 1
Total	2,111 8 3	3,075 8 6	964 0 3

All these items compare satisfactorily with those of last year and show an increase, but comparison is difficult as these figures are for fourteen months as against twelve months of last report.

6. *The Tinnevelly Chank Fishery.*—The total number of shells paid for was 126,377 excluding 240 Idintakarai chanks which remain unsold as compared with 163,527 in 1916–17. Quality was again most excellent and these shells well maintain their reputation as the first in all round size and quality yielded by any fishery in India and Ceylon. The drop in yield was in great part due directly to the unfavourable nature of the weather from the beginning of January till the middle of March; the adverse factor was unusually strong and chilly winds, which rendered regular work difficult and unpleasant. Had it not been that the weather during November and December (1917) was milder than usual, the result would have been disastrous. In some as yet not understood way the weather conditions also affected adversely the worms which constitute the food of the chank, causing a scarcity on many of the beds. This in turn resulted in the scattering of the chanks in search of food instead of the usual concentration wherever the worms abound.

The men had poor earnings over the season as a whole, and this has had a very discouraging effect upon their *morale*. Every step was taken by means of towage and camping facilities, payment of batta on days of very small catches, and the like, to hearten them and induce them to preserve. The number of divers employed was rather better than in the preceding year at the commencement, but the poor earnings in February and March caused a serious diminution which in turn adversely affected the catches. For the greater part of the time six crews only worked regularly.

Recruitment.—Four Arab divers were recruited in Ceylon; one died of acute diarrhœa a few weeks after arrival and of the remaining three, two were so discouraged with their poor earnings that they requested permission to transfer to Rameswaram, which was allowed.

7. *The Ramnad Chank Fishery.*—The good results here compensated amply for the poor harvest of the Tinnevelly beds. The total of full-sized shells fished at the various centres last year and in the preceding year were as follows:—

	1916–17.	1917–18.
Rameswaram	158,942	192,252
Kilakarai and South Vedalai ...	16,295	17,295
Pillaimadam, Jadhi quality ...	9,175	22,410
Do. Patti do. ...	...	3,851
Tirupalakudi	69,809	28,952
Total ...	254,221	264,760

8. Work in the Vedalai and Rameswaram sections was particularly remunerative and demonstrated once more how the divers working in

Ramnad district appreciate the facilities and help given to them. Prior to the beginning of the Rameswaram fishery at the end of February, I had considerable misgiving as to the adequacy of the labour force available, as the merchants who work the Ceylon fisheries desired to take the divers to Ceylon at an early date. The men were themselves anxious to join our fishery and eventually after protracted negotiation with the leading divers, an arrangement was made whereby a larger number than was the case last year, pledged themselves to work in the Government fishery. This satisfactory outcome assured the success of the fishery from the beginning and I now hope that the custom of taking part in the Rameswaram fishery before going to Ceylon, has become an established one. It is however only because the facilities we give are superior to those which obtain in Ceylon.

9. The Rameswaram fishery began on 27th February 1918 and lasted till 24th April 1918 when the Muhammadan divers held their Kandiri celebration in the camp prior to dispersing. The services of the motor launches "Pearl" and "Leverett" and of the chartered steam tug "Eider" were invaluable for towing the boats to and from the beds. Last year the charter of the "Eider" cost Rs. 3,600; this year, by having the use of the "Leverett" we were able to shorten the period of charter considerably so that the bill for her use was reduced to Rs. 3,000 in spite of increase in the rate of hire. The "Leverett" though small is very powerful for her size and was able to tow at a fair speed as many as 36 boats in ordinary weather.

10. *Acquisition of land sites.*—In order to erect further permanent buildings at the various chank centres in Ramnad district, a site for a beche-de-mer factory, store and office was acquired at Tirupalakudi, the extent being 42·4 cents and the cost Rs. 289–1–6. The Government Order sanctioning the acquisition is No. 137, Revenue, dated 18th January 1917. In addition, by the sanction conveyed in G.O. No. 552, Revenue, dated 6th September 1917, G.O. No. 716, Revenue, dated 27th November 1917, a small site of 4 cents was acquired for Rs. 2–4–0 at South Vedalai and another of 74½ cents for Rs. 199–10–8 at Olakkuda, Rameswaram, respectively. The former is for the erection thereon of a chank godown, the latter for a second set of divers' lines.

11. *Tirupalakudi.*—At this centre work was hampered till late in the season by strong winds which made the sea too muddy for effective operations. This section of the coast is the most unfavourably situated of any in regard to this factor: only in exceptional seasons is the weather sufficiently good to permit of large quantities of shells being fished, and here as at Tuticorin, the weather was almost uniformly adverse throughout

the year, aggravated by unseasonable and heavy rains in August, which caused floods of muddy water to pour into the sea at a time when normally the water should be clear. The quality of the shells is poor and of low market value, hence it is difficult to give the divers a rate which will adequately remunerate them. Only by running a beche-de-mer fishery in conjunction, can their earnings be made enough to induce them to carry on the chank fishery. Without the help of the subsidiary industry named the men could not be prevented from abandoning the chank fishery in favour of other work.

12. *Chank fishery in Ceylon.*—Partly to prevent the Tuticorin chank divers from drifting away to other employment during the six months when fishing cannot be carried on at Tuticorin (a danger more pressing nowadays than formerly on account of the marked increase in the cost of living since the war began), and partly to gain exact knowledge of the fishing stations and general course of operations in the chank fishery in Ceylon, by sanction of Government (G.O. No. 1435, Revenue, dated 21st May 1917) four crews of divers were sent to participate in the Ceylon fishery during three months ending October 1917.

13. Weather conditions were generally unfavourable and the total catch of the 32 divers amounted to 29,432 full-sized shells only. The cost of these including incidental charges was Rs. 3,029-5-5, the cost of supervision amounted to Rs. 263-13-5, and we add the crew's wages and the upkeep of the launch "Sutherland" sent with the canoes for towage purposes, the total expenditure totalled Rs. 3,926-6-1. The shells were eventually sold by tender at the rate of Rs. 155 per 1,000, the total receipts being Rs. 4,577-6-3. The net profit therefore was Rs. 651-0-2, but it should be remembered that much of the expense charged against these shells was not incurred specifically on this account; the wages of the clerk and peon, and the wages of the "Sutherland's" crew would have had to be met from the department's budget whether this expedition had been sent or not. Hence the real profit is considerably greater than the apparent one. The prices to the divers were regulated by the rates current in Ceylon during the fishery, and averaged one anna five pies per shell.

Our divers were fairly well satisfied as they were able to support themselves and their families through a period when other earnings would have been difficult to make. Had the weather been even moderately favourable, they would have obtained much better results.

14. The quality and size of these Ceylon shells compare most unfavourably with those from our Ramnad and Tinnevelly fisheries; a very large proportion are so small that if fished on the Madras coast they would be confiscated without payment and as many as possible returned alive to the sea.

15. *New chank contracts.*—During the past year, the produce of the Tinnevelly chank fishery for the three years 1918–19 to 1920–21, inclusive, was offered to public tender. The highest offer was made by Messrs. J. E. Dutt & Sons of Dacca, who have held the contract for the Tinnevelly and the Ramnad shells for several years past. The rate obtained is Rs. 325 per 1,000, which compares most favourably with Rs. 121 received during the past three years. There was considerable competition and all offers were largely in excess of the previous rate.

16. The South Arcot chank lease for a two years' period from 1st April 1918, was also re-let to M.R.Ry. Subbarayalu Chettiyar of Cuddalore at an enhancement of Rs. 600 per annum, from Rs. 900 to Rs. 1,500 per annum. The chank market is now higher than it has been for many years; one of the chief reasons appears to be the difficulty experienced by the bangle manufacturers in getting large sized shells other than those from the Madras coast, in consequence of the gradual decrease in the average size of the shells fished in Ceylon waters, where no size limit is imposed.

17. *The beche-de-mer industry.*—During 1917–18, the following quantities of material were brought from the chank divers of Tirupalakudi :—

Large size (Nos. I and II qualities)	39,520
Small size (No. III quality)	19,407
	58,927

The former yielded as cured weight of 1,710 lb., the latter of 431 lb. or 2,141 lb. in all. The material cured to December 1917 was despatched to Singapore for sale and so far no intimation has been received as to its disposal. The second lot, which comprises the material cured in the second half of the season, remains on hand. The prices that will be obtained, it is afraid, may not be very satisfactory, especially in view of the fact that there is a heavy loss in exchange on remitting the proceeds to India. But these are war times and trade in this article suffers materially at present from difficulties of transport and from the unrest in China.

18. The actual cost of the raw material together with all charges amounted to Rs. 688–4–7, so that if we value the produce on hand at the rates obtained last year, the receipts on the operations will amount to Rs. 657–10–9. In view of the makeweight which the prosecution of this industry exercises upon the carrying on of the chank fishery, the small loss that may be sustained may be considered as an incidental and necessary expense of this latter fishery.

However with the return of normal conditions in the world, a considerable profit should then be earned.

19. A report upon the revival of this industry with full details of the methods of cure practised was issued as a constitutent report in Bulletin No. XI during the past year. A general review of the trade was appended. This publication should prove very useful to any one engaging in this industry and Mr. Alvain Scule, lately head of the Fisheries Department in the Philippine Islands, writes that he considers this report as one of the most valuable as well as one of the most interesting contributions to our knowledge of the trepang fisheries that has ever been written.

20. *Pearl fishery*.—Inspection has again been made of the banks off the Tinnevelly coast and again no pearl oysters. save a few scattered ones have been found. In addition a careful inspection of the ground outside of the chain of islands stretching from Pamban to Vaippar was made in November 1917 with the aid of the motor inspection schooner "Lady Nicholson." The result again was negative, no deposits of any kind being found. This same inspection was also useful in settling once for all, the question of whether there be any fishable beds of chanks sea ward of these islands. None were found. The ground generally is a rocky plateau with scanty life outside of sea-fans (Gorgonids), sea-whips (*Juncea*) and non-commercial sponges. Hence we may conclude that there is no possibility of extending the chank fishery to new grounds anywhere off the southern coast of the Rāmnād district.

21. The small bed of scattered pearl oysters, on the seaward eastern edge of the chank beds *north* of Rameswaram Island still survives and gives off its periodical sworms. Some of these appear to have settled on the Dhanushkodi jetties, as a number were found by the contractor when demolishing the South pier there. By the courtesy of the Port Officer, Pamban, these were forwarded to me for examination. They proved to be from nine months to 18 months of age, and some appear to have contained a few seed pearls.

22. The scheme to erect a pearl-culture laboratory on Krusadai Islands is still in abeyance in view of the heavy cost involved and the poor market at present for culture pearls. A modified scheme is under consideration.

23. *Tuticorin fish farm*.—The results during the past year are again an improvement upon previous years. The total expenditure consisted of Rs. 684-6-7 made up as follows :—

	RS.	A.	P.
Wages	566	9	1
Nets and sundries	117	13	6
	684	6	7

while the receipts amounted to Rs. 1,496–7–0 as against Rs. 925–13–9 in the preceding year. The net profit for the period under report deducting supervision and depreciation charges comes to Rs. 614–0–5. The catches and respective sales consisted of—

	RS.	A.	P.
9,052 lb. prawns	932	2	9
4,718 lb. fish	239	14	3
Rental for crab fishery	48	0	0
Miscellaneous	276	6	0
Total ...	1,496	7	0

As in 1916–17, the bulk of the prawns were sold to line fishermen, who greatly appreciate the advantage of getting regular supplies of bait.

24. The long delayed completion of the sluices and weir is expected at the end of next month ; thereafter the running of this lagoon as a real fish-farm will begin. The present and past satisfactory results have been attained in spite of great difficulties, which the provision of sluices should largely decrease, to the additional financial profit of the undertaking.

25. *Pulicat oyster park.*—The collection of spat and the supply of cultivated oysters have now become established routine. There is nothing special to chronicle for the past year save that appreciation of their quality and of the care taken in cultivation under hygienic conditions has resulted in a considerable extension of sales, whereby the small loss in 1916–17 upon working has been further reduced. The financial aspect is shown as follows :—

	1917–18 (14 months).			1916–17 (12 months).		
	RS.	A.	P.	RS.	A.	P.
Expenditure	1,124	5	9	805	10	0
Receipts	843	6	6	459	9	6
Loss ...	280	15	3	346	0	6

The expenditure consisted of wages Rs. 377, freight Rs. 337–1–3, miscellaneous charges Rs. 410–4–6.

26. *Zoological specimen supply.*—This phase of our activities has continued to expand and the sales of specimens, sent out at little over cost price, to educational institutions throughout India aggregate Rs. 736 for the past year as against Rs. 576 in 1916–17. The disabilities mentioned in last year's report continue to retard progress.

27. A large range of specimens including both museum and dissection specimens in alcohol and formalin, and educational type collections of shell fish and crustaceans, were exhibited at the second Madras Exhibition

held at the end of 1917. The type collections have been specially in demand for schools and were it convenient to supply larger numbers, there would be little difficulty in finding purchasers. It is quite clear that as zoological teaching and nature study extend in India, an increasing demand is springing up for specimens such as this department has begun to supply. Colleges in the north India continue to furnish the bulk of orders and it would seem that students in the north have greater aptitude and preference for zoology than those of the south.

28. *Research.*—During the past year Bulletin No. XI was published. The following marine reports appeared therein, viz.:—

I. The Edible Molluscs of the Madras Presidency.

II. A new protozoan cause of widespread mortality among marine fishes.

III. A statistical analysis of the Fishing Industry of Tuticorin.

IV. The Indian beche-de-mer industry; its history and recent revival.

29. These four papers totalled an aggregate of 150 pages of letterpress and were illustrated with 38 original text figures. An investigation of Indian boat designs, viewed both from the present day aspect and from the wider standpoint of the ethnologist, has been completed, and will probably be published by the Asiatic Society of Bengal as one of their memoirs. A summary of the facts and a statement of the main conclusion were read before the Ethnological section of the Indian Science Congress in January of the present year. The outstanding deduction is contained in the theory, based largely on widespread similarities in boat construction and corroborated by certain affinities of physical characters among the chief fisher caste of the extreme south, that there is a strong infusion of Polynesian blood in the coast population of certain southern and western districts in India.

30. Investigations relating to the migrations of sardines, surface drift in the Gulf of Mannar, the biological survey of Siluvathurai lagoon, now turned in a fish-farm, and the details of the varied fishing methods employed on the coast of India, engaged attention during the year and it is hoped to publish some of the results at an early date. So far as possible the aim is kept in view of putting upon permanent record all important facts which are ascertained from time to time. One of the most regrettable occurrence of life in India, is the frequent loss of valuable data through the postponement or neglect of publication. The inevitable consequence is waste of valuable time in succeeding years, when other inquirers have again to traverse unnecessarily the whole ground in the absence of satisfactory records.

31. *Deputation to Baroda.*—Consequent upon the request of the Government of Baroda for the loan of my services to make a second investigation of the fishery resources of their State, with the sanction of the Madras Government, I spent one month from 9th December 1917 in Kathiawar. I found that the steps taken by the Baroda Government to develop their pearl fishery on the lines of the recommendations I drew up ten years ago, had resulted satisfactorily in providing a new source of livelihood to some hundreds of the poorer coast population and in adding considerably to the local revenue. The stow-net fishery for Bombay Ducks carried on in large deep-sea fishing boats of 10 to 20 tons burden as well found and roomy as many British herring boats was investigated, together with other phases of the local fishing industry. A report has been furnished, embodying a number of recommendations for further development. It was gratifying to find that the two Baroda fishery officers are men who had been trained (as far as facilities permitted) by the Madras Fisheries Department; both are doing most useful work and promise to become valuable technical officers.

32. *Socio-economic work.*—I am glad to report that three co-operative societies were formed among the fishermen of Ramnad district during the past year, two in Rameswaram Island and the other at Karangadu. It is too early to say how far they will prove successful, as the men are by nature improvident and averse to regular repayment of money obtained on loan. Much depends locally upon the success of these pioneer societies and everything is being done to assist the management. Many of the members are divers who participate in the Rameswaram fishery and as this has given good returns this season, the men are in an unusually good position to take up shares. No better year could have been chosen for the inception of this work.

33. *Loans for the purchase of boats.*—As borrowers cannot be made to see the necessity for regular repayment, however small be the monthly rate agreed upon, loans have been restricted to a minimum. At the present time there are five outstanding amounts, which represent as many boats bought with Government assistance. All loans have been substantially reduced during the season although payments have been irregular as mentioned above. No amounts have become unrecoverable, and no losses are probable as the balances of the loans made are amply secured upon the boats purchased, which stand in the name of the Superintendent, Pearl and Chank Fisheries, as representing Government, pending the extinction of the advances.

The actual amounts outstanding on 31st May 1917 totalled Rs. 340 owed by 6 men; on the same date this year the amount was Rs. 363 owed by 5 men.

34. *Temperance work.* of a practical nature has again been carried on among the Tuticorin divers in the shape of a coffee stall intended to counter the attractions of the toddy shop. Coffee and country cakes are supplied at cost price and again I have to report gratifying success. Similarly at Rameswaram, arrangements were made with two shop-keepers to open coffee stalls in the camp; sites were given them free and I am glad to say that the divers, whose conduct and behaviour appreciably improved, welcomed this step. The stalls did a thriving trade as the men's earnings were usually sufficient to permit them to indulge in the luxury of a cup of tea or coffee. It is worth noting that tea appears to be rapidly ousting coffee in these men's estimation. I believe that simple practical methods such as this, conjoined with a scheme for the education of the village boys in the real things that matter in life, hold out great promise in the problem of bettering the condition and outlook of our fishing population.

35. *Recruitment for the Overseas Forces.*—I am glad to be able to record that this section has contributed its share to the forces being recruited for service abroad. Mr. W. Stopford, Engineer of the "Lady Nicholson," and Raman, his assistant, have been both joined the motor mechanic service in East Africa; I trust they may be found useful members of the force and return safely with such added experience as may qualify them for higher employment than their old posts. This office has also canvassed extensively the fishermen of this coast with a view to obtain recruits for the Labour Force in Mesopotamia and several men have thereby been induced to join. So far as possible the progress of the war and the justice of our cause have been explained to the divers from time to time. Our small staff has also contributed to the War Loan as far as it was able, the result being an investment of Rs. 2,186.

36. I am glad to report that the staff in general worked with marked zeal and ability. I desire to take this opportunity both to bring this to the notice of Government and to thank the officers themselves for their loyal co-operation in carrying on the work of the marine section of this department; the hours of duty are often of necessity very protracted during the continuance of the chank fishery, while the conditions of life at outstations on the Ramnad coast and when camping in the islands off Tuticorin, are disagreeable and trying; little notice can be paid to "official holidays" during the busy season.

(2)

REPORT OF WORK DONE IN THE PISCICULTURAL BRANCH DURING THE YEAR ENDING 30TH JUNE 1918.

Owing to the lamented death of Mr. H. C. Wilson on the 11th of April 1917, Mr. B. Sundara Raj, Assistant to the Piscicultural Expert, took

charge of the branch till 7th February 1918, when as a tentative measure I was appointed as the Piscicultural Expert and Mr. B. Sundara Raj as the Assistant Director.

Staff.—Excepting certain minor changes there was no change in the staff during the year.

Tours.—Mr. B. Sundara Raj visited the following districts on tours of inspection and investigation :—

The Kurnool district in June 1917, the Nellore district in July, October and November, January and February, the Chingleput district in May and June 1917 and April and May 1918, the Tanjore district in August and September, the Nilgiris in April and May 1917 and South Kanara (with myself) in April and May 1918.

In South Kanara the four sites for fish farms selected by Mr. H. C. Wilson were inspected with a view to follow up his proposals for the improvement of the fisheries of the district.

The Sub-Assistant and two Assistant Inspectors toured in the districts of Kurnool, Bellary, Anantapur, Cuddapah, Chittoor and Chingleput in connexion with the tank investigation scheme.

Regarding the various operations in hand the Assistant Director reports as follows :—

" *Sunkesula fish farm.*—The work of the farm continued to be satisfactory. A notable feature was the successful breeding of the highly esteemed species *Etroplus suratensis* by providing artificial nests made of Cuddapah slabs. The fish deposit their adhesive eggs on the under surface of these slabs and are asciduous in the care of their eggs and young. Experiments during the previous two years failed apparently for want of such facilities. The Kurnool-Cuddapah canal and tanks in the neighbourhood could now be stocked with the fry which was the main object of Mr. Wilson in introducing this valuable species from the Madras estuaries into Sunkesula.

" *Pudur scheme.*—The Public Works Department are doubtful of successfully impounding water in the Mudupanchala cheruvu, the largest of the three tanks covered by the scheme. The Executive Engineer, Kurnool, is still investigating the matter.

" Meanwhile the gourami have begun to breed and in the absence of extensive rearing grounds (which the Pudur scheme was intended to provide) the fry had to be transported to Ippur.

" *Live-fish market.*—The live-fish market at Kurnool which was closed in 1915 after the first year of its work owing to difficulties in management was reopened for the sale of fish from July to January—a season when fish is scarce in Kurnool—and was run this time by a contractor who was

supplied with 884 lb. murrel and other fish for Rs. 101-4-6 from the Sunkesula fish farm. The sales would have been a greater success had it not been for the virulent outbreaks of plague. Two ponds for storing the fish in Kurnool town are under construction.

"*Nallamalais scheme.*—The two ponds and quarters at Praema have been completed and the ponds were stocked with a selection of larvicides from the Ippur farm for breeding purposes. As these ponds are insufficient, another site near Mahanandi for additional ponds has been selected and the plans and estimate for them have been prepared.

"*Colair scheme.*—The scheme for a floating hatchery and the improvement of the Colair lake fishery is still pending owing to the presence of fixed engines. The Collector has been requested to take action in the matter.

"*Cuddapah anti-malarial scheme.*—The 9 miles of road up to Pallamadugu has been repaired but the new jungle road from thence to Peddagadi is being laid.

"*Ippur fish farm.*—The work of this new farm progressed well during the year. It holds a large head of gourami and larvicides and is the main source of supply, at present, of larvicides to the public and local bodies in the Presidency. The growing demand for larvicides has necessitated the utilization of the whole Ippur Kamini tank for the cultivation of these fish. The food fish reared simultaneously in the tank are being departmentally fished and marketed.

"*Red Hills scheme.*—A suitable site for fry ponds and staff quarters has not yet been secured. The matter is still under correspondence.

"*Powder factory scheme.*—The gourami introduced from Java and Mauritius two years ago bred for the first time last December. Many permanent water tanks of the Presidency operated by the department continued to be stocked with the acclimatized species *Etroplus suratensis* from this farm.

"Owing to the isolated situation of two of the ponds some *Etroplus* were stolen from one of them, but precautions have been taken to prevent the recurrence of such thefts.

"*Chingleput scheme.*—A scheme to combat malaria in the Reformatory School at Chingleput by draining the moat into the adjoining river by means of a channel costing Rs. 12,590 was drawn up by the authorities of the Reformatory School. Subsequently an anti-malarial *cum* pisciculture scheme costing only Rs. 7,500 proposed by this department was sanctioned by Government. The latter scheme while preventing the spread of malaria by stocking the moat with larvicidal fish will enable the water of

the moat to be used for the rearing of valuable food fish. The work has been taken in hand by the Public Works Department.

"*Hilsa hatchery*.—Owing to the failure of seasonal floods in the Coleroon, the Hilsa fishery was almost a failure. Only four solitary ripe fish (females) were secured. The eggs though few were sufficient to verify the results of the previous year's investigations and to furnish further data of scientific value.

"*Nilgiri fishery*.—I visited the Avalanche hatchery and inspected some of the trout streams on the plateau in April 1917. Trout fingerlings were transferred from the fry ponds to the streams as usual. This fishery and the conservancy of the Bhavani and Moyar have since been entirely managed by the District officers and the question of its future control is pending before Government.

"*Acclimatization and introduction of exotic and indigenous species*—*Gourami*.—The two consignments of gourami from Java and Mauritius which are kept in the Powder Factory and Sunkesula farms bred during the year. Some 200 of the resultant fry from both these farms have been transferred to specially prepared ponds at Ippur where they are rapidly growing—fry which were only $\frac{1}{2}$" or $\frac{3}{4}$" in December have grown to 6" within the last five months.

"*Tench and English carp*.—As stated in last year's report these fish have not yet bred though they have grown well during the last four years in Sunkesula.

"As regards indigenous species, a number of estuarine food fish in addition to *Etroplus suratensis* are being acclimatized to fresh water at the Ippur and Powder Factory farms for introduction into inland waters. One of the largest and esteemed local carp *Catla catla*, which is non-indigenous to waters south of the Kistna, is being introduced into a series of tanks in the south.

"*Stocking of tanks and channel*.—As in the previous year the Kurnool-Cuddapah canal and the permanent water tanks in the districts of Kurnool, Cuddapah, Bellary, Salem, Chingleput and North Arcot were stocked with fish from the Sunkesula and Powder Factory farms.

"As desired by Government in their Memorandum No. 19-A/17-2, Revenue, dated 22nd March 1917, a preliminary survey of all suitable tanks of the Presidency was undertaken and nine districts (Kurnool, Nellore, Cuddapah, Bellary, Anantapur, Chittoor, North Arcot, Chingleput and Tanjore) have been covered. A scheme for dealing with the tanks in three contiguous districts (Nellore, Chingleput and North Arcot) with proposals for additional fish farms at suitable centres is under preparation. The remaining districts will be taken up in due course.

"*Fishery rentals.*—The fisheries of the Cauvery-Coleroon fetched Rs. 21,886 in excess of the compensation payable to the five district boards concerned for the year 1917–18. The compensation payable to the District Board of Tanjore was reduced from Rs. 26,620 to Rs. 23,031 and in consequence a sum of Rs. 14,356 for 1914–15 to 1917–18 was resumed from the district board funds (vide G.O. No. 4073, Revenue, dated 15th December 1917). The rentals from tanks and channels operated by the departments showed an increase of Rs. 23,691 over the compensation paid to the local bodies.

"*Larvicidal operations.*—Considerable progress was made during the year in organizing and developing the work of breeding and distributing larvicidal fish to the public and to local bodies. 83,500 fish were sold for Rs. 835 to municipal and local bodies and military authorities with full instructions for stocking their waters and in some cases their men were trained in such operations. A leaflet of instructions entitled 'The value of fish as natural enemies of mosquitoes in combating malaria' was published and some 150 copies have already been distributed to the purchasers of larvicidal fish.

"At the request of local bodies and the Sanitary Commissioner, officers of the department conducted anti-malarial inspection of wells and tanks in the municipalities of Bellary, Negapatam and the Vriddhachalam union. Owing to the shortage of trained hands, it has not been found possible to depute officers for this work in all cases, and some of the local bodies and Native States have been requested to send their own men to Madras for training. This is advantageous to the parties concerned as they will have a trained man always on the spot, while the cost of deputing a man for training is the same as that of obtaining the services of this department officers. The Madras Corporation stocked a number of wells with fish in 1915, but in a number of cases the fish introduced had disappeared. In response to a request of the Malaria Board received through Government the matter was investigated and a complete report was submitted to Government. The investigations in Madras and in other places go to prove that the failure of larvicidal operations conducted by local bodies without reference to this department is chiefly due to the procuring of unsuitable larvicides locally. The ignorant fishermen who are entrusted with this work are incapable of selecting the proper varieties of fish and very frequently introduce unwittingly the fry of predaceous kinds. Moreover such stocking deprives the waters in the neighbourhood from which the fish are obtained, of their own natural stock of larvicides. Hence it was urged that the only way out of the difficulty is for the local

bodies to obtain advice from this department and supply of fish from the fish farms.

"As desired by Government a register has been maintained in which the supply of larvicides is being recorded and the Sanitary Commissioner is furnished with particulars of such supplies in each case.

"*Deputation to Hyderabad.*—Government in G.O. Mis. No. 4030 of 13th December 1917 sanctioned my deputation to Hyderabad in May or June 1918 for a second inspection of the Oosman Sagar tank. Owing to pressure of other urgent work it has not been found possible to undertake the inspection this year."

Experimental deep-water fishing.—One of the great drawbacks in tank fishing is the inability of the local fishermen to capture fish except when a tank is about to dry up, due to their primitive methods and implements. This is a source of loss both to the fishermen and to the consumer, inasmuch as the fishermen do not realize the full value of their catches owing to an abundance of fish placed in the market and the consumer is deprived of fresh fish throughout the major part of the year and at times the whole year if the tank does not dry up. Moreover a tank that is not regularly fished does not yield the maximum weight of fish. Government tanks that fail to dry up in any year therefore fetch very little or no rentals. With a view to remedy those evils experiments were initiated in some of the large irrigation tanks near Madras to devise methods and implements to fish tanks throughout the year.

V. GOVINDAN,
Piscicultural Expert, Government Fisheries.

ANNEXURES.

STATEMENT I showing summary of charges and receipts of the Fishery Department, 1917–18.

Particulars.	Charges.	Receipts.	Difference.
	RS. A. P.	RS. A. P.	RS. A. P.
I. Supervision and research.	59,100 9 1	274 8 0	−58,826 1 1
II. Marine fisheries	69,167 12 11	1,01,577 0 6	+32,409 3 7
III. Inland fisheries	56,122 6 4	69,573 12 6	+13,451 6 2
IV-A. Factories	23,902 14 8	51,051 9 2	+27,148 10 6
IV-B. Vessels	9,815 14 1	3,753 4 3	−6,062 9 10
V. Capital expenditure—10 per cent thereon ...	1,939 14 1	Nil.	−1,939 14 1
	2,20,049 7 2	2,26,230 2 5	+6,180 11 3

STATEMENT I (*a*) showing details for "Expenditure" in Statement I.

Particulars.	Capital expenditure	Charges—Running expenditure.					
		Salaries.	Establishment.	Allowances.	Supplies and services	Contingencies.	Total.
	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.
I. Supervision and research.	407 14 0	20,567 7 10	16,982 1 8	11,527 1 6	1,843 10 3	8,180 3 10	59,100 9 1
II. Marine fisheries.	1,819 8 5	8,148 6 2	10,416 4 11	2,473 13 11	46,638 14 3	1,490 5 8	69,167 12 11
III. Inland fisheries.	1,448 2 9	1,394 9 5	1,176 7 2	Nil.	53,551 5 9	Nil.	56,122 6 4
IV-A. Factories—							
(1) Cannery ..	7,312 1 4	Nil.	3,445 10 6	562 8 0	9,013 9 3	Nil.	13,021 11 9
(2) Tanur ..	589 10 11	Nil.	2,373 9 10	562 8 0	7,945 1 1	Nil.	10,881 2 11
IV-B. Vessels ...	7,821 7 5	Nil.	4,056 7 8	132 6 6	5,626 15 11	Nil.	9,815 14 1
V. Capital expenditure—10 per cent on the above	19,398 12 10	...	...	...	...	...	1,939 14 1
	1,939 14 1	30,110 7 5	38,450 9 9	15,258 5 11	1,24,619 8 6	9,670 9 6	2,20,049 7 2

Details for II Marine Fisheries.

Supplies and services.

	RS. A. P.	RS. A. P.
A. Chank fisheries—		
(1) Ramnad fisheries ...	*29,244 5 7	
(2) Other fisheries	12,274 11 5	
		41,519 1 0
B. Pearl fisheries—		
(1) Examination of pearl banks	486 11 3	
(2) Pearl fisheries running expenses	294 8 6	
		781 3 9
C. Vessels—		
(1) Lady Nicholson ...	790 9 4	
(2) Sutherland	666 6 2	
(3) Pearl	412 3 1	
		2,169 2 7
D. Other work—		
(1) Pulicat oyster farm ...	868 7 6	
(2) Marine fish farm ...	612 10 10	
(3) Beche-de-mer	618 4 7	
		2,169 6 11
Total ...		46,638 14 3

* Includes a sum of Rs. 4,000 being the fifth year's proportion of the total consideration paid in 1913-14 for a fifteen years' lease of the Ramnad Chank Fisheries.

Details for III. Inland Fisheries.

Supplies and services.

	Rs. A. P.	Rs. A. P.
A. Tank stocking—		
(*a*) Compensation to district boards	44,946 14 0	
(*b*) Tank stocking	464 12 5	
		45,411 10 5
B. Other work—		
Sunkesula fish farm	3,841 3 9	
Hilsa hatchery and lower anicut	210 3 6	
Ippur fish farm	1,715 13 7	
Powder factory charges ...	611 6 5	
Nallamalais	537 13 3	
Investigation of new schemes.	333 8 6	
House boat maintenance ...	308 5 5	
Motor boat expenses ...	481 4 11	
		8,139 11 4
		53,551 5 9

Details for IV-B. Vessels.

Supplies and services.

	Rs. A. P.	Rs. A. P.
Turbinella	1,868 12 11	
Fishing canoes...	3,096 8 6	
Leverett	292 15 6	
Machwas	368 11 0	
		5,626 15 11
		5,626 15 11

STATEMENT I (*b*) *showing details for "Receipts" in Statement I.*

Details for II. Marine Fisheries.

	Rs. A. P.
(*a*) Receipts from all chank fisheries, including beche-de-mer fisheries, as per statement III	98,173 9 0
(*b*) Receipts from sale of zoological specimens and other miscellaneous receipts ...	822 13 5
(*c*) Receipts from marine fish farm	1,588 3 7
(*d*) Receipts from oyster culture at Pulicat ...	992 6 6
	1,01,577 0 6

Details for III. Inland Fisheries.

	Rs.	A.	P.
(*a*) Rentals from tanks and rivers, etc., the fisheries of which were taken over by this department (vide Statement II)	68,637	8	0
(*b*) Receipts from sale of fish larvicides ...	835	0	0
(*c*) Other miscellaneous receipts	101	4	6
	69,573	12	6

Details for IV-A. Factories.

(1) Cannery—			
(*a*) Actual receipts (amount remitted into treasury) from sale of canned, etc., fish.	31,548	4	3
(*b*) Amount outstanding on 1st July 1918 but since realized	1,854	2	7
(*c*) Value of manufactured goods at hand on 1st July 1918.	7,020	10	6
	40,423	1	4
(2) Tanur—			
(*a*) Actual receipts (amount remitted to treasury from sale of cured, etc., fish). ...	8,019	4	10
(*b*) Amount outstanding on 1st July 1918 since realized	1,724	3	5
(*c*) Value of goods on hand on 1st July 1918.	884	15	7
	10,628	7	10

Details for IV-B. Vessels.

(*a*) Receipts from fishing canoes	3,171	10	9
(*b*) Turbinella	55	8	0
(*c*) Ratnagiri Machwas	526	1	6
	3,753	4	3

NOTE.—The sum of Rs. 274-8-0 noted as receipts against "I. Supervision and Research" represents the amount of rent realized from the Fisheries Bungalow at Ennur.

STATEMENT II.—Statement showing the names of tanks or tank system, canal or canal system, and rivers, the amount of compensation paid and amount of rentals realized for 1917–18.

Name.	Compensation paid.			Rentals realized.			Reference to Government Orders taking the fisheries.
	RS.	A.	P.	RS.	A.	P.	
Cauvery and Coleroon ...	34,898	0	0	56,784	2	0	G.Os. Nos. 1797, Revenue, dated 20th June 1914; 711, Revenue, dated 8th March 1917; and 1886, Revenue, dated August 1916.
Kurnool-Cuddapah canal...	2,553	14	0	1,165	0	0	G.O. No. 3660, Revenue, dated 12th December 1913.
Dusimamandur and Kaveripakkam tanks.	3,789	0	0	4,685	0	0	G.O No. 856, Revenue, dated 21st March 1917.
Chembarambakkam and Madurantakam tanks.	2,195	0	0	3,950	0	0	Do.
Singanamalla tank ...	117	0	0	...			Do.
Gudur and Karedu tanks ...	185	0	0	250	0	0	Do.
Rangasamudram and other tanks.	200	0	0	12	8	0	Do.
Kamalapuram tank ...	500	0	0	860	0	0	G.O. No. 1686, Revenue, dated 22nd July 1916.
Daroji tank...	155	0	0	270	0	0	G.O. No. 2330, Revenue, dated 31st July 1911.
Barur and connected tanks.	120	0	0	166	0	0	G.Os. Nos. 2720, Revenue, dated 9th September 1912; and 953, Revenue, dated 30th March 1914.
Penukondapuram tank ...	118	0	0	141	0	0	G.O. No. 3016, Revenue, dated 13th October 1913.
Badaikhan tank	16	0	0	66	0	0	G.O. No. 610, Revenue, dated 16th March 1916.
Belegal tank							
Markapur tank	95	0	0	219	4	0	G.O. No. 3016, Revenue, dated 13th October 1913.
Venkatapuram tank ...	...			42	8	0	G.O. No. 100 I., dated 20th February 1914.
Kocheruvu	...			20	0	0	Do.
Ippur, Kamini and Puduparti tanks.	5	0	0	6	2	0	G.O. No. 495, Revenue, dated 23rd February 1915.
Total ...	44,946	14	0	68,637	8	0	

STATEMENT III.—Summary of expenditure and receipts of all chank and Beche-de-mer fisheries, season 1917-18.

Expenditure.

	RS.	A.	P.
Expenditure incurred in conducting the Tinnevelly chank fishery	8,962	5	9
Expenditure incurred in conducting the Ceylon chank fishery	3,029	5	5
Expenditure incurred in conducting the Rāmnād chank fishery	23,835	13	6
Expenditure incurred in conducting the Sivaganga chank fishery	246	13	6
Expenditure incurred in conducting the Beche-de-mer fishery	977	6	1
Fifth year's proportion of the total consideration paid in 1913–14 for a fifteen years' lease of the Ramnad chank fishery	4,000	0	0
Total expenditure ...	41,051	12	3
Balance being net profit on the season's operations	57,121	12	9
	98,173	9	0

Receipts.

Value of chank and other receipts from Tinnevelly chank fishery	15,866	15	8
Value of chank and other receipts from Ramnad chank fishery	70,411	10	11
Value of chank and other receipts from Ceylon chank fishery	4,577	6	3
Value of chank and other receipts from Sivaganga chank fishery	269	13	5
Estimated value of 2,141 lb. of beche-de-mer on hand	657	10	9
Rent for the Tanjore chank fishery	4,890	0	0
„ South Arcot chank fishery ...	900	0	0
„ Chingleput and Nellore chank fishery	600	0	0
	98,173	9	0

STATEMENT IV.—Trading account for the year ended 30th June 1918—Government Fisheries Cannery, Chaliyam.

	Rs. A. P.	Rs. A. P.		Rs. A. P.	Rs. A. P.
To stock of canned goods on 1st April 1917	9,762 2 0		By sale of canned fish remitted to treasury from 1st April 1917 to 30th June 1918 ...	30,908 8 2	
To stock of cured fish on 1st April 1917	4 10 6		By sale of cured fish.	132 15 1	
To stock of oil and guano on 1st April 1917	200 2 0		,, guano ...	115 4 0	
Pit manure on 1st April 1917 ...	13 12 0		,, fried oil ...	250 2 0	
Fried oil	127 8 0		,, fish oil ..	94 2 0	
Tins manufactured at the cannery on 1st April 1917 ...	1,229 8 2		,, prawn shells ...	33 12 0	
		11,337 10 8	,, miscellaneous products.	13 9 0	31,548 4 3
To cost of solder, tin plate, empty cans (imported), tin, rosin, soldering fluid, turpentine, varnish, etc. ...	6,971 15 0		By value of canned, etc., fish sold but not realized and remitted to treasury on 30th June 1918	1,854 2 7	1,854 2 7
To cost of fuel (firewood, coal, kerosene oil, petrol and other oils) ...	655 14 0		By value of manufactured goods on hand on 1st July 1918—		
To cost of fish used for canning and curing, etc. ...	1,839 8 9		Guano	130 0 0	
Fish condiments including oil for packing	1,702 7 0		Fried oil ...	66 14 0	
Cost of sundry stores, such as soda ash, cotton waste, spirit, vaseline, etc. ...	136 15 6		Prawn shells ...	1 8 0	
Salt and preservatives	100 13 0		Pit manure ...	23 0 0	
Packing materials, such as packing cases, baskets, brown, etc., papers, twine and straw and wire nails used.	651 11 0		Canned fish ...	6,407 3 0	
Labels and rubber rings for tins ...	400 3 0		Miscellaneous. products	2 14 9	6,631 7 9
Manufacturing wages—wages of temporary staff and extra labour ...	2,273 15 7		Empty cans manufactured in the cannery	...	389 2 9
Railway freight ...	1,518 2 9				
Petty coolie and carriage	494 13 10				
		16,746 7 5			
Gross profit (transferred to profit and loss account) ...	...	12,338 15 3			
		40,423 1 4			40,423 1 4

GOVERNMENT FISHERIES CANNERY, CHALIVAM.

Profit and loss account for 1917–18.

	RS.	A.	P.		RS.	A.	P.
To rent of Bangalore stall	46	8	0	By gross profit transferred from trading account	12,338	15	3
To fixed travelling allowance of Sir F. A. Nicholson (12½ per cent only debited)	562	8	0				
To pay of permanent staff (50 per cent only debited) ...	1,171	10	11				
To service stamps ...	603	0	0				
To advertising and printing charges ...	188	8	6				
To depreciation and interest at 10 per cent	1,616	0	0				
To net profit ...	8,150	11	10				
	12,338	15	3		12,338	15	3

STATEMENT V.—Trading account for the year ended 30th June 1918
Government Fisheries Yard, Tanur.

	RS. A. P.	RS. A. P.		RS. A. P.	RS. A. P.
To stock of cured fish on 1st April 1917.	1,099 2 2		By sale of cured fish remitted to treasury on 1st April 1917 to 30th June 1918.	5,453 14 7	
To stock of fish oil and foots on 1st April 1917 ...	370 1 1		By sale of fish guano.	969 12 1	
To stock of guano on 1st April 1917 ...	11 4 0		By sale of fish oil and foots	420 15 0	
To stock of miscellaneous products on 1st April 1917 ...	43 15 4		By sale of prawn shells	75 5 2	
		1,524 6 7	By sale of pit manure.	86 2 9	
To cost of fish used for curing operations	3,332 3 2		Miscellaneous receipts	1,013 3 3	8,019 4 10
To cost of oil and guano curing operations	431 9 5		By value of goods sold but not realized and remitted to treasury on 30th June 1918... ...	1,724 3 5	1,724 3 5
To cost of salt and preservatives ...	129 11 3				
To cost of sundry stores used ...	237 8 2		By value of manufactured goods on hand on 1st July 1918—		
To cost of fuel, such as firewood, kerosene oil, etc. ..	226 14 0		Cured fish ...	284 3 11	
Packing materials ...	380 12 9		Fish guano ...	296 10 10	
Wages of temporary staff and of coolies.	1,371 11 8		Fish oil and foots	210 1 7	
Railway freight on parcels of cured fish.	748 1 3		Prawn shells ...	50 3 3	
Petty coolie and carriage	820 11 6		Pit manure ...	43 12 0	884 15 7
Watering and manuring charges for coconut plants ...	95 4 2				
Cost of fish oil purchased	675 0 0				
		7,637 7 4			
To gross profit (transferred to profit and loss account) ...	...	1,266 9 11			
		10,628 7 10			10,628 7 10

GOVERNMENT FISHERIES—STATION, TANUR.

Profit and loss account for 1917-18.

	RS.	A.	P.		RS.	A.	P.
To rent of Bangalore stall	90	0	0	By gross profit transferred from trading account	1,266	9	11
To rent of Cannanore yard	72	11	0	By net loss	997	1	3
To fixed travelling allowance of Sir F. A. Nicholson (12½ per cent debited) ...	562	3	0				
To pay of permanent staff (50 per cent debited)	978	8	2				
To service stamps ...	350	0	0				
To depreciation on plant, machinery, shed, etc., 2,000 — 200 + 300 = 2,100 at 10 per cent	210	0	0				
	2,263	11	2		2,263	11	2

Note.—A sum of Rs. 1,412 was received within the year (25th June 1918) on account of the supply of oil to the Munitions Board in view of the expenditure by the West Coast station, Tanur branch, in salaries, travelling allowance and contingencies. This was not included in the receipts ; it converts the loss on Tanur into a small profit.

Order—No. 3461, Revenue, dated 17th October 1918.

Miscellaneous

The Fisheries department continued to do good work throughout the year in the development of the industries entrusted to its care. The report does not deal with the soap experiments as the soap factory is no longer under the control of this department.

2. The Pisciculturist's branch made progress under the charge of Mr. Sundara Raj. The proposals for the utilization of the Mopad Reservoir for piscicultural operations and those for the cultural and sanitary development of the Vellore Fort Moat are under the consideration of the Government. The cannery operations were extended to some extent and the net profits were considerably greater but the scale of operations is still insufficient to meet the general demand. It is satisfactory to note that a scheme for the refrigeration of fish has been elaborated and will be put into immediate operation. The effect of the absence of freight on the oil and guano operations has been to some extent counterbalanced by demands from the Military department and the jute mills and by the formation of groups of producers acting as intermediaries for large customers. The Government note that these groups will be formed into co-operative societies and will thus be further consolidated.

3. The Honorary Director has submitted preliminary proposals regarding inshore fishing experiments in Madras. He has shown that the experiments already conducted were a success from a fishery point of view, though financially they resulted in a small loss on account of the cost of bringing boats and men from the West Coast and of inducing the men to remain at Madras. The Government have just sanctioned the Honorary Director's proposals for continuing the experiments on a larger scale and for a longer period.

4. The department is continuing its philanthropic work in the social and economic development of the fisherfolk and the fact that Mr. Govindan is being invited by them to visit the villages and organize societies is a tribute to the success of his work. The Government are glad to receive the assurance of Sir Frederick Nicholson that the people themselves are beginning to understand the need for education and it is hoped that the proposals approved in G.O. No. 2048, Revenue, dated 27th May 1918, will have far-reaching developments.

5. The war has rendered it impossible to proceed with the work of the Krusadai pearl oyster farm, the Marine Aquarium at Madras, and deep sea exploration. Proposals are however under consideration for the establishment of the Krusadai farm on a smaller scale.

6. A trial chank fishery expedition to Ceylon was a successful feature of the year and with the sanction of the Government of India the experiment is being repeated.

7. The Government are glad to note that the department was awarded a gold medal and the diploma of excellence for canned and the cured fish at the Madras Exhibition of Industries in 1917–18 and that people of other provinces are taking an interest in the work of the department.

8. The Government agree that the primary object of the department is not revenue but development and progress. It is nevertheless satisfactory to observe that the working of the department during the year shows a small profit.

(True extract)

M. YOUNG,

Additional Temporary Secretary to Government.

Editors' Table.

LIST OF MADRAS FISHERIES BULLETINS ISSUED UP TO DATE WITH THEIR CONTENTS AND PRICES.